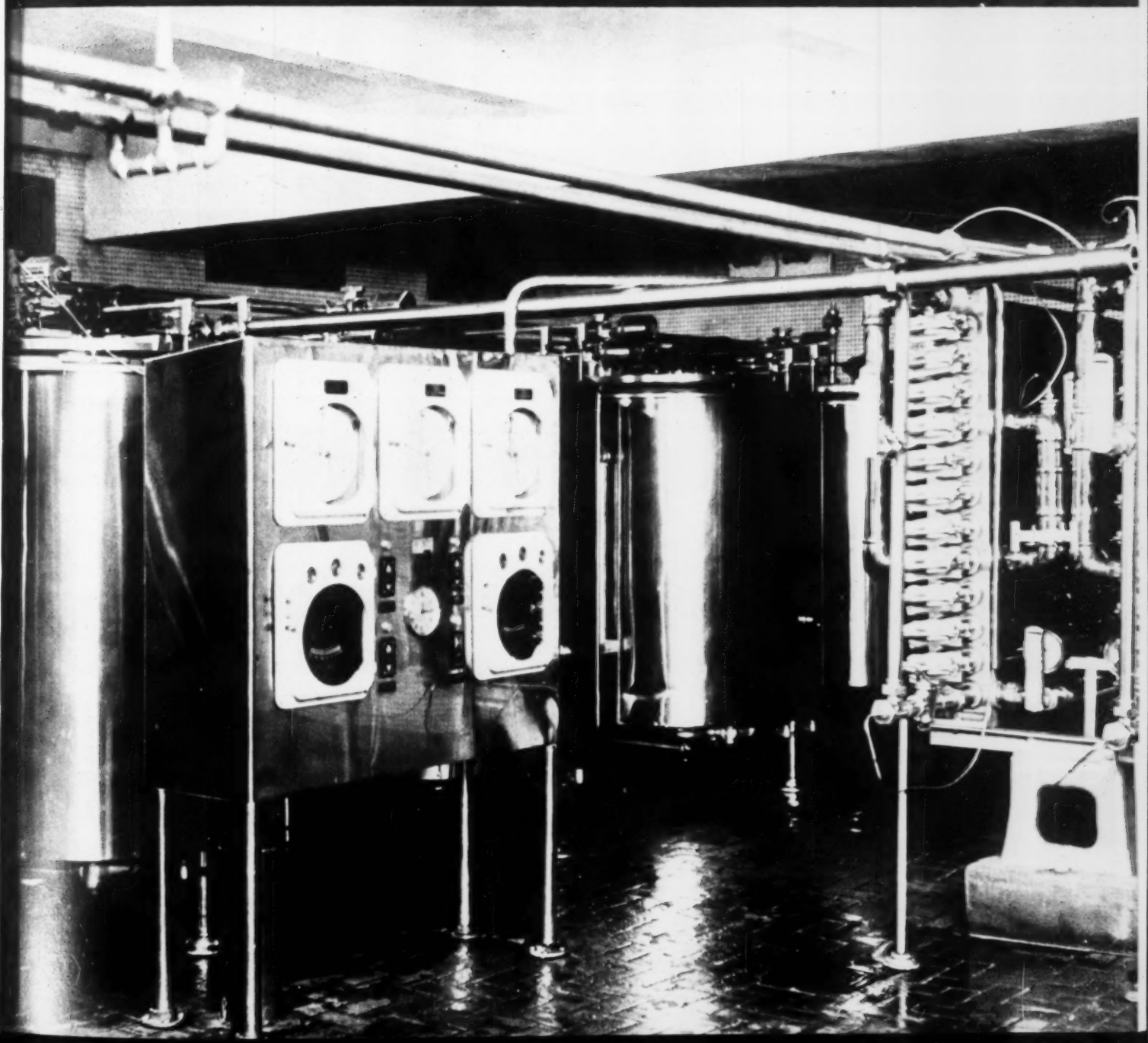
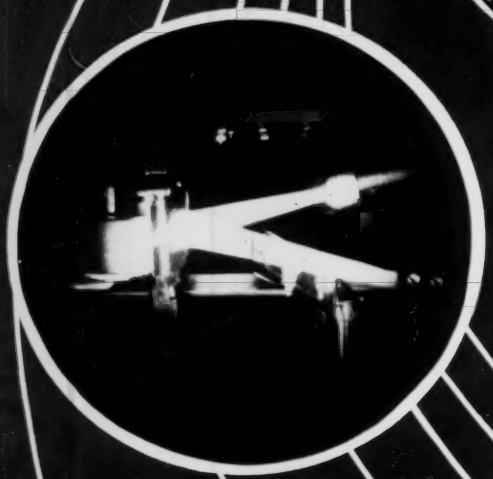
Instruments

THE MAGAZINE OF Measurement and Control

Vol. 12
MARCH
1939
No. 3



TAG



3 TO 6 FURNACES CONTROLLED BY ONE CELECTRAY

with photoelectric detection employing - -

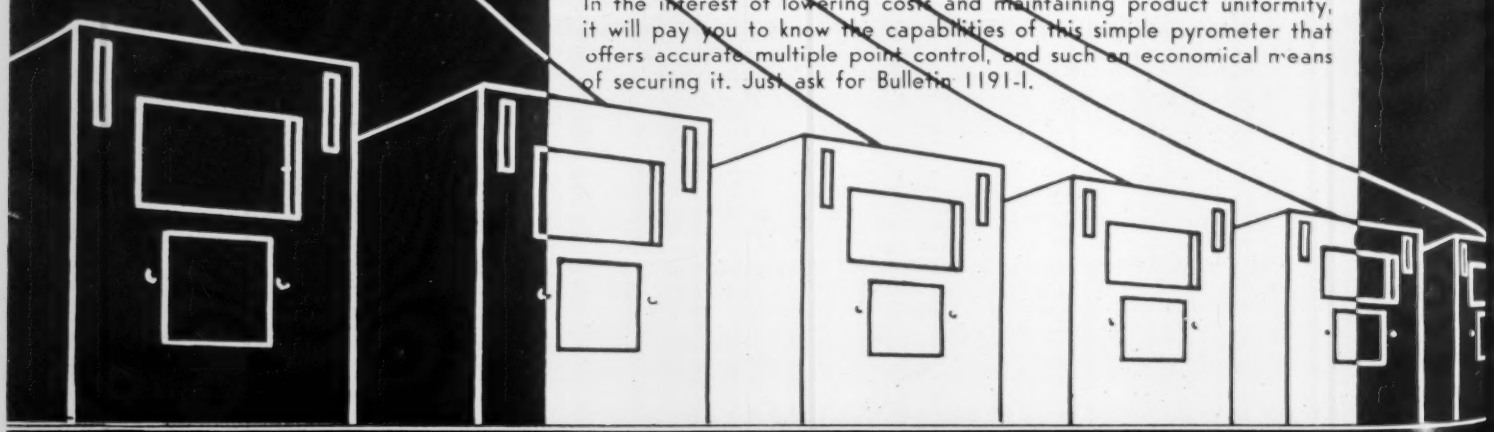
A PHOTOELECTRIC TUBE
A MIRROR GALVANOMETER
A BEAM OF LIGHT

Now it is possible to control 3 to 6 furnaces, or a 3- to 6-zone furnace, with a single, comparatively inexpensive instrument . . . Only TAG has provided this needed, economical means of multiple point control with a new development—CELECTRAY Multiple Point Indicating Controller.

The closeness of control expected of some single point instruments is frequently surpassed by this New CELECTRAY, due to its extraordinarily high sensitivity and quick action.

There are many other notable CELECTRAY Features, including independent control point setting and terminals for connecting to motor-operated valves or magnetic contactors without using intermediate external relays.

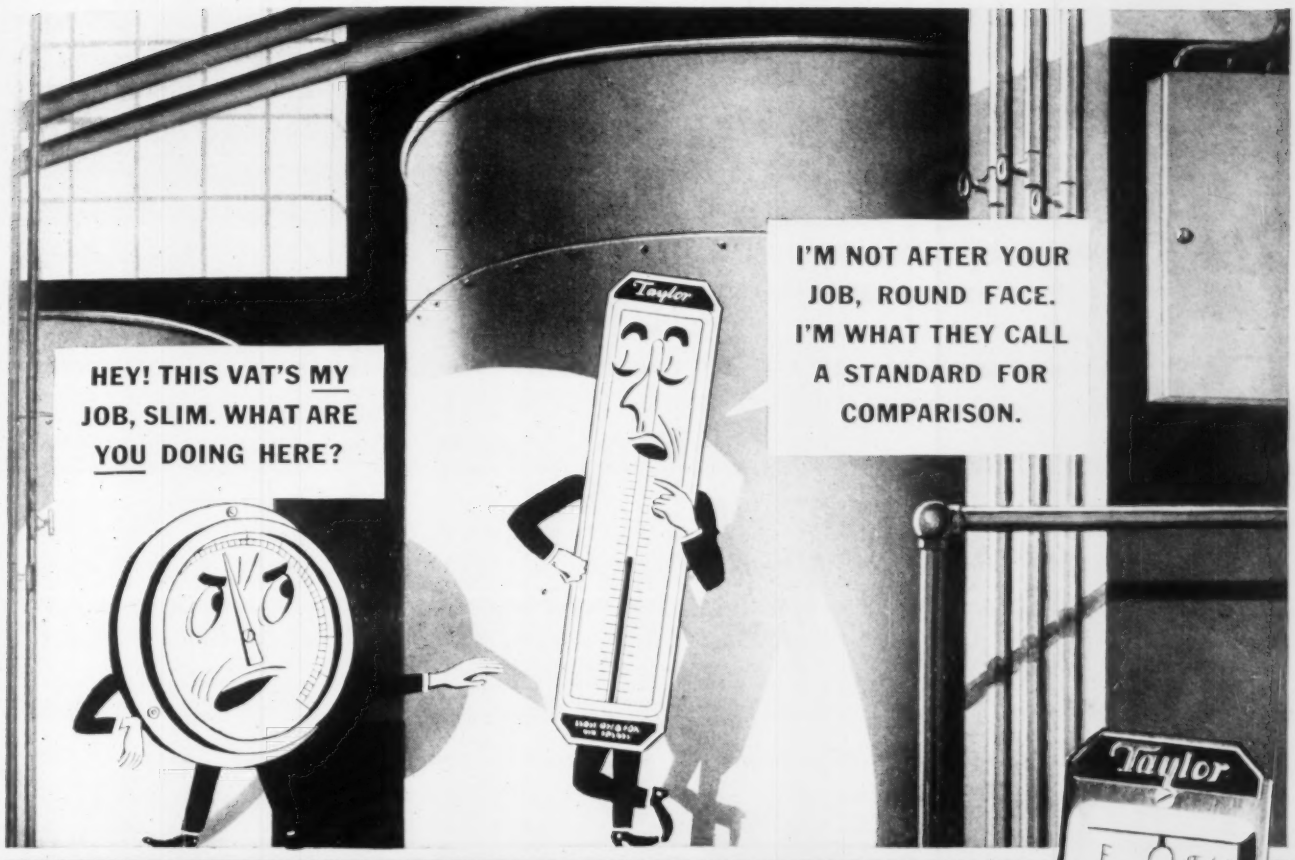
In the interest of lowering costs and maintaining product uniformity, it will pay you to know the capabilities of this simple pyrometer that offers accurate multiple point control, and such an economical means of securing it. Just ask for Bulletin 1191-I.



C. J. TAGLIABUE MFG. CO.

Park & Nostrand Ave's., Brooklyn, N. Y.

TAG TAGLIABUE BROOKLYN N.Y.


HEY! THIS VAT'S MY JOB, SLIM. WHAT ARE YOU DOING HERE?
I'M NOT AFTER YOUR JOB, ROUND FACE. I'M WHAT THEY CALL A STANDARD FOR COMPARISON.
Taylor

Let 'em argue... they're both friends of yours!

▶ **Let the boys have a little heated discussion. They're both eager to check the vital temperatures in your plant. And there's one thing about measuring heat that's as true today as ever: no matter how many dial thermometers you may need, the mercury-in-glass thermometer is your basic standard.**

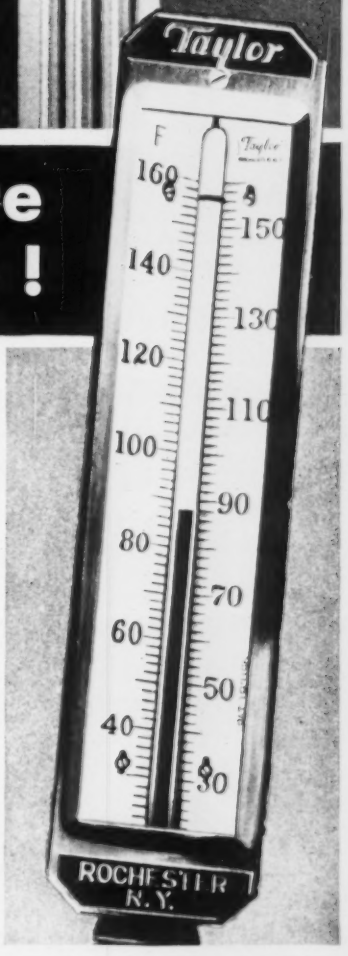
FOR FORTY YEARS or more the basic instrument for temperature indication in industrial plants has been the mercury-in-glass thermometer. And today, this type of thermometer is still a basic instrument in industry — especially where a check-up with other instruments is wanted.

For more than forty years Taylor has made the finest industrial thermometers available—and today, Taylor leads the field by a wider margin than ever, with the new BINOC Thermometer, which adds easier reading to the long-acknowledged Taylor accuracy.

BINOC Tubing makes the Taylor Industrial Thermometer 2 to 5 times easier to read. It doubles the angle of vision, without sacrificing magnification. It eliminates bore reflection, which often causes errors in the reading of temperatures. It concentrates more light on and back of the mercury column, which also increases visibility.

These are a few of the reasons why Taylor BINOC Thermometers can be read without strain or squint, quickly, accurately, and from greater distances. Why not let the Taylor Representative give you an actual demonstration in your plant? Get in touch with him today on the way to get it—or write Taylor Instrument Companies, Rochester, New York. Plant also in Toronto, Canada. Manufacturers in Great Britain—Short & Mason, Ltd., London, England.

Taylor
Indicating Recording Controlling
TEMPERATURE, PRESSURE, FLOW *and* **LEVEL INSTRUMENTS**



● This may not be just the right Taylor BINOC Thermometer for your particular plant. But you can get one marked in an easy-to-read range that *will* fit your needs exactly.

FOR GREATER PROFITS
Control Your Liquid Assets

LIQUIDOMETERS provide continuous dependable and accurate knowledge of liquid levels in such industries as:

AIRCRAFT
AUTOMOTIVE
BAKING
BEVERAGES
BREWING
BUSSES AND TRUCKS
CHEMICALS
CLEANING AND DYEING
COMMUNICATIONS
DIESEL
ELECTRICAL
FOOD
INSTITUTIONS
IRON AND STEEL
LAUNDRIES
MARINE
PAINT
PAPER
PETROLEUM
PLASTICS
POWER
PROCESS
RAILROAD
RUBBER
SOAP
TANK TRUCKS
TEXTILE
TRANSPORTATION

Gauging such liquids as:

Acetone, Acids, Alcohols, Asphalts, Beer, Benzene, Benzol, Butane, Castor Oil, Caustic Liquids, Carbon Bisulphide, Condensate, Corn Syrup, Diesel Oils, Film Dopes, Formaldehyde, Fuel Oils, Gasolines, Gins, Glycerine, Inks, Ice Cream Mix, Kerosene, Lacquers, Linseed Oil, Lubricants, Milk, Naphtha, Paper Stock, Pentane, Phenol, Pyrofax, Salad Oils, Soap Liquids, Sulphur Dioxide, Tar Compounds, Thinners, Toluol, Turpentine, Water, Whiskies, Xylol.

Liquidometer Remote Reading Gages

automatically indicate or record liquid levels. No pumps, valves or auxiliary units required to read them. Balanced hydraulic transmission system ingeniously compensates for temperature variations on communicating tubing. Accuracy unaffected by variations in specific gravity. Approved by Underwriters Laboratories and similar bodies for gauging hazardous liquids. Models are available for remote signals, automatic control of pumps, etc. DIRECT READING models available where remote reading is not required.

Lovelometers (Dial Type Hydrostatic Gauges)

Operate on hydrostatic principle of establishing balance between head of liquid and an indicator. Dial indication featured. No liquid to expand or contract and create errors. One dial can be arranged to gauge a group of tanks.

Liquidometer Thermometer

Completely free from inaccuracies due to temperature variations at indicator or along transmission tubing.

"Liquids worth storing are worth measuring"

THE LIQUIDOMETER CORP.

36-27 SKILLMAN AVE.
LONG ISLAND CITY, NEW YORK

Instruments
THE MAGAZINE OF MEASUREMENT and CONTROL

Vol. 12 — No. 3

MARCH 1939

FRONT COVER: Dairy Instrumentation
Sheffield Farm Co.'s 57th Street Plant, New York City. 40,000 lbs./hr. capacity pasteurizing system. Three recording thermometers and two temperature controllers.
Courtesy C. J. Tagliabue Mfg. Co.

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Published Monthly on the 15th by
THE INSTRUMENTS PUBLISHING COMPANY
1117 Wolfendale Street, Pittsburgh, Pa.

RICHARD RIMBACH, Managing Editor — M. F. BEHAR, Editor

BRANCH OFFICES

Boston: James Condon, 25 Brimmer St. (Lafayette 9760)
New York: R. K. Farnham, 118 E. 28th St. (Lexington 2-4637)
Chicago: William Farnham, 201 N. Wells St. (Andover 4180)
Cleveland: Burdette Phillips, 405 Erie Bldg. (Main 9645)
Philadelphia: R. K. Farnham, 1533 Cherry St. (Rittenhouse 2530)

Annual Subscription: U. S. $2.00. All other countries $3.00 *payable in advance* (remit by New York draft).

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Entered as second-class matter January 26, 1932, at the post office at Pittsburgh under the Act of March 3, 1879.

Instruments

THE MAGAZINE OF Measurement and Control

J. F. BEHAR, Editor

A Milestone—and a Moral

TEN outstandingly useful papers were presented at the conference on Instrumentation in the Processing Industries held March 2 and 3 under the auspices of Carnegie Tech's department of Chemical Engineering. Three of these papers are published in this issue. Others will appear in future issues . . . but not *all* others. Among those which will never see print is one which brought out so many moot points that many earnest debaters decided to meet in extra sessions. Groups sat up late discussing matters affecting all instrument users—matters brought out not only in "controversial" papers but in *all* papers. Never has there been any meeting on the subject of instrumentation where enthusiasm ran so high, where the attendance represented so many industries, where the authors knew their subjects so well and where the audience included so many authorities on industrial instruments and controllers.

Never has there been such a "meaty" meeting on the subject of instrumentation: where so much *permanent good* was done, benefiting instrument users directly, and also indirectly by advancing the state of the art through carefully-assigned technical papers on carefully-chosen subjects, to be published where they reach 90% of those whom it is desired to benefit.

In fine, *Instruments* hands a bouquet to Professor McCabe, head of Carnegie Tech's Chemical Engineering Department, and to Professor Monrad who actually ran the Conference. Part of this bouquet should go to Carnegie Tech's Metallurgical Department which blazed the trail last October by holding the Conference on Instrumentation in the Steel Industry—probably the world's first industrial instrumentation symposium.

The words "processing industries" suggest a sort of fenced-in corral, but this conference covered a larger field, for Monrad wisely jumped over the fence whenever the common good required an unlimited scope. As a matter of fact, of the 131 who registered, about fifty came from companies manufacturing non-chemical products. Geographically, nearly all States East of the Mississippi, and Canada, were represented. Nearly all instrument users present were *Instruments* readers.

If you—a "typical" *Instruments* reader—live within 500 miles of Pittsburgh and stayed away of your own free will, you'll regret it; if your chief kept you, *he'll* regret it. Not only did you miss two days of self-improvement but your company may lose money to competing firms that sent alert engineers to gather priceless ideas. To be sure, you will read most of the papers but, in the first place, you can't "get" the big ideas back of each the way you do from the authors—frequently in uncensored words and in the second place the discussions will not be printed, and many say that these rapid-fire repartees were the richest part of the formal sessions. Even more valuable than the formal discussions, declared some instrument engineers, were the "round-table" meals—and the "bull sessions" both evenings.

Moral—The moment you see the announcement of the next Instrumentation Conference, no matter what particular industry is featured in the official title, plan to attend it. If you live within 500 miles of where it is to be held, make it a "must."

We mean, of course, the next conference to be planned and conducted with the aid of consultants representing you through the staff of your magazine (the papers to be published in *Instruments*). We have extended our aid, as your servant, to groups, committees and other bodies outside of Pittsburgh. Watch for announcements.

Temperature Symposium

Plans are being made by the American Institute of Physics to hold a symposium on "Temperature, Its Measurement and Control in Science and Industry" in the Fall of this year. Last April an informal conference of men interested in temperature, held at the National Bureau of Standards in Washington, brought out so much interest and so many suggestions that a decision to hold the symposium was quickly made. An advisory committee was formed to consider the time and place, and coöperation by industries and allied sciences principally concerned. It consists of:

Chairman, C. O. Fairchild, Director of Research, C. J. Tagliabue Mfg. Co.; Dr. E. F. DuBois, Medical Director, Russell Sage Institute of Pathology, and Professor of Medicine, Cornell University Medical College; Dr. Gustav Egloff, Director of Research, Universal Oil Products Co.; Dr. John Johnston, Director of Research, U. S. Steel Corp.; Dr. Walter G. Whitman, Head, Department of Chemical Engineering, Massachusetts Institute of Technology, and Dr. H. A. Barton, Director, American Institute of Physics.

The symposium will be organized by a committee of authorities in the various aspects of temperature. This committee will shortly be appointed and its membership announced.

Among the purposes now contemplated for the symposium are: (1) Coördination of the treatment of the subject of temperature in the several branches of science and engineering, (2) review of principles and recording of recent work, (3) accumulation, if possible, of contributions for a comprehensive text to be published after the symposium, (4) emphasis on the importance of temperature as a branch of physics, (5) improvement of technical curricula through making available up-to-date information.

Advisory Committee Chairman Fairchild has prepared the following list of topic groupings:

(1) Principles and Elementary Theory; (2) Teaching; (3) Laboratory Methods; (4) Methods and Technique Peculiar to Various Sciences; (5) Methods and Technique Peculiar to Various Industries and Processes; (6) Miscellaneous Thermometric Methods, Devices, Phenomena; (7) Special Thermal Phenomena of Broad Interest; (8) Industrial Temperature Instruments, Modern Designs and Features; (9) Standard Tables for Thermometry and Pyrometry.

Those interested should communicate with Dr. H. A. Barton, Director, American Institute of Physics, 175 Fifth Ave., New York City.

THE MONTH'S NEW INSTRUMENTS

In this department we strive to report each month ALL the new devices for measurement, inspection, testing, metering and automatic control—in the form of concise technical descriptions.

When writing to manufacturers directly, please mention this department as your source of information.

Or write to Information Section, Instruments Publishing Company.

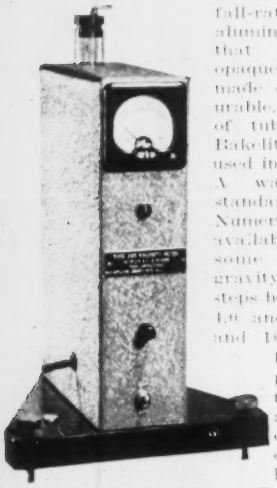
Portable Process Timer

Though originally designed for dark-room use where settings may be in hundredths of a second, "Photrix Electronic Timer" is available in standard models with timing ranges up to 100 seconds (including double-range models) for controlling loads up to 1500

watts a.c. or 1200 watts d.c. Employing a network of capacitances, resistances, etc., it has no moving part other than the circuit-closing and -opening relay. Timing is determined by electrical constants whose values are said to be negligibly affected by temperature, humidity, aging, etc. Moreover, timing scale of each dial is geometrically progressive, or logarithmic, so that limit of error is nearly a constant fractional-percent of whatever duration for which dial has been set. Electrical timing method obviates need of rewinding or resetting: pressing the push-button closes the load circuit, which is opened automatically at end of interval for which dial has been set, independently of how long push-button is held down. Right-hand toggle switch is for keeping load circuit closed when experimenting, etc. Unit illustrated measures $6\frac{3}{4}$" × $3\frac{1}{2}$" × $4\frac{1}{2}$".—*Dr. F. Lacombera, 46 E. 59th St., New York City.*

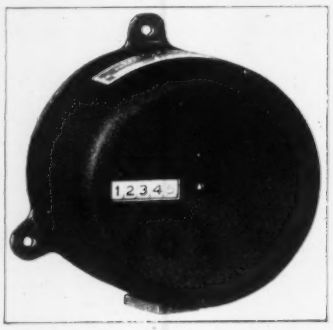
Falling-ball Viscosimeter with Electrical Timer

Said to represent an improvement over original Hercules falling-ball method, new "Type 295 Electronic Viscosity Meter" employs an electrical method of timing the fall-rate of steel or aluminum balls, so that viscosities of opaque liquids are made directly measurable. Any number of tubes (glass or Bakelite) may be used interchangeably. A water-jacket is standard equipment. Numerous balls are available, including some with specific gravity variable in steps between 1.2 and 1.9 and between 1.9 and 10.0, the latter being gold-plated. These novel graduated balls facilitate study of materials having thixotropic properties; minor effects may thus be investigated at essentially same rate of shear in each determination.—*Tech Laboratories, 7 Lincoln St., Jersey City, N. J.*



Time Meter

New "Time Totalizer" registers "on" duration of a-c. circuits, consists of number wheels geared to a synchronous motor so that they record time in hours and tenths.



is enclosed in a dust-proof case with adequate provision for mounting and convenient wiring.—*Production Instrument Co., 702 W. Jackson Blvd., Chicago, Ill.*

Equipment Timer

Designed for built-in use, new "Series 50" automatic timer has normally-open switch, silver contacts for control of 15 amps. a.c. at 125 volts. Stock timing ranges are 15, 30 and 60 minutes. Timer is basic-

ally similar to and dimensionally identical with "Series 75CH" except for operating method and newly-designed switch mechanism. Hair-spring-escapement type movement is built by Lux Clock Mfg. Co. Switch mechanism is mounted on inner side of Bakelite switch base, with screw terminals on outer side for wiring connections. Diameter of timer housing 2⅝"; depth (from inside of mounting flange to base) 1⅜". Mounting method, said to be unique, permits timer to be securely clamped to panel for flush dial installation.—*Walser Automatic Timer Co., Graybar Bldg., New York City.*

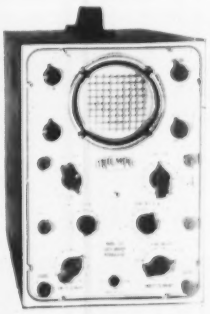
Intensifier Type Five-inch Cathode-ray Tube

Radically new type of intensifier element said to represent "first fundamental improvement affecting sensitivity since inception of cathode-ray tubes four decades ago," consists of one or two metallic deposit rings near screen end of c-r. tube, serves to accelerate the electrons *after* deflection. Illustrated in maker's new "54-9-T" 5" tube with

intensifier feature and gun-structure refinements giving better focus and modulating characteristics. In operation, electron gun is operated at same potentials and in same manner as other DuMont tubes of corresponding screen diameter. Intensifier electrode may be connected to final anode and tube operated in conventional manner. If, however, an additional voltage approx. equal to accelerating electrode potential be applied between intensifier and second anode, effect of former is to brighten the pattern equivalent to doubling accelerating voltage, yet not causing so great sensitivity decrease as would normally result. In terms of screen pattern size: instead of a 50% reduction which doubled accelerating voltage would normally produce, the voltage with use of accelerating element reduces pattern size by 18%. Positive potential required between second anode and intensifier electrode may be taken from existing c-r. tube power supply by addition of a single half-wave rectifier operating from same transformer winding and connected in reverse polarity. Filter requirements may be satisfied by use of a light filter capacitor and a high-resistance bleeder of approx. 10 megohms.—*Allen B. DuMont Labs., Inc., 2 Main Ave., Passaic, N. J.*

Cathode-ray Oscillograph

New "Model 830 Oscillograph Wobbulator" is a 3" cathode-ray oscillograph with built-in frequency-modulated 1000 kc. oscillator, said to perform all regular functions of an oscillograph plus alignment of tuned radio circuits by the resonance curve method and overall analysis of a-f. amplifiers. In this latter function a signal is generated which changes in frequency from 0 to 10 kc. 60 times a second; resulting pattern shows amplitude characteristic of audio amplifier under test. A-f. response of amplifiers or audio coupling units may be "instantaneously tested" over a band of frequencies between 0 and 25 kc although a 5 or 10 kc. range is usually sufficient for radio and p.a. amplifiers. Although a regular 3" c-r. tube and several standard radio tubes are employed, instrument measures 7¼" × 10" × 14" deep. Net weight, 22¼ lbs. An input sensitivity of 0.1 volts r.m.s. per inch has been achieved through use of single-ended, 6SJ7 amplifier tubes. A new thyratron saw-toothed sweep circuit provides a continuous range of 7 to 30,000 cycles.—*Triumph Mfg. Co., 4017 W. Lake St., Chicago, Ill.*



Wheelco

REMOTE TEMPERATURE LIMIT or CONTROL

•

20° to 600° F.

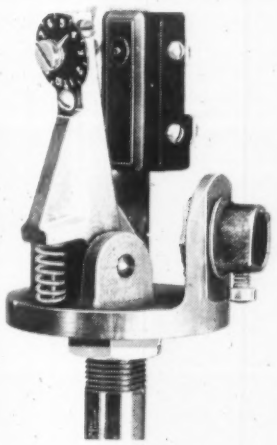
•

A highly efficient remote bulb, temperature sensitive fill type instrument designed to control or limit temperature. With a "lock-in" switch mechanism may be used as a high or low limit controller or alarm.

Detailed literature on request

Wheelco Instruments Co.
1933 So. Halsted St. Chicago, Ill.

NEW



HEAT CONTROL

Temp. Range—100 to 600 F.

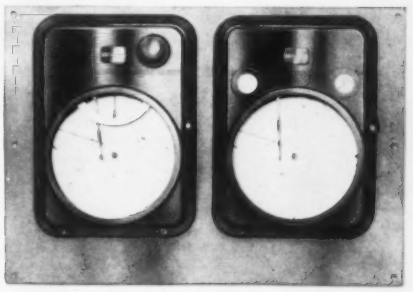
Will give accurate control in ovens, tanks, incubators, water baths, dryers, chemical processes, and air ducts.

Send for Bulletin V-1

BURLING INSTRUMENT CO.
239-241 Springfield Avenue
NEWARK, N. J.

Flow Ratio Control

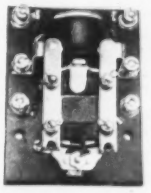
Automatic control of the rate of flow of one fluid in definite ratio to the flow of a second fluid is accomplished by means of new Flow Ratio Controller, a feature of which is an arrangement which permits



changing ratio at any time by turning a knob on outside of case. Flow Ratio Controller consists of two instruments: a standard flow recorder and a standard flow recorder-controller. The rate of flow is measured and recorded by one instrument, which also sets the control point on the second. The latter then records and controls the flow proportionately to the first, depending upon the ratio selected.—*The Bristol Co., Waterbury, Conn.*

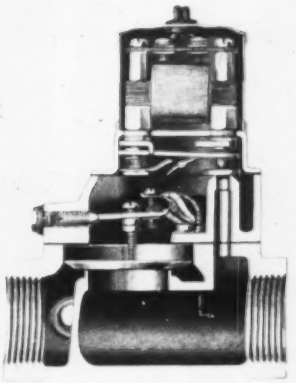
Midget Mechanical Latch-in Electrical-reset Relays

New line of mechanical latch-in electrical-reset midget relays is available in 110-volt 6-amp. a.c.; 220-volt 3-amp. a.c.; 115-volt 1-amp. d.c. They are provided with two coils. When lower coil is energized, armature picks up and latches in energized position. Energizing upper coil releases latch, allowing armature to drop out. New relays are supplied with coils for either momentary or continuous duty. No power is required in the coil circuit to hold armature in either position. These relays are used in connection with 2-wire thermostats, etc.—*Stathers Items Inc., 139 North Juniper St., Philadelphia, Pa.*



Slow-acting Gas Valves

New slow-opening type gas valves are said to provide a soft ignition at low flame followed by a gradual opening to full flame. Stop primary flow of adjustable volume, a



hesitation period, allowing time for uniform draft to be established, followed by slow opening to full capacity. Closing cycle is snap-acting. Available in ¾" and 1" pipe tap sizes; operate on 20 volts.—*Julius P. Friez & Sons, Baltimore St. & Central Ave., Baltimore, Md.*

Stop and consider this unique combination of features of the new ROTAMETER

1. A twist of the hand loosens the two knurled nuts and permits the end fittings to swivel about to any desired position. Thus horizontal connections can be made in any direction whatsoever. Vertical connections also provided.

2. By unscrewing the knurled nuts altogether the meter comes apart completely so that the glass metering tube can be pulled out WHILE IN ITS CASE for cleaning or for exchange. No danger of striking the glass tube against a metal part.

3. Glass metering tubes well protected by enclosing metal tube having two slots to admit light and permit observation of float position.

4. F & P precision-bore, interchangeable glass metering tube with F & P fused colored graduations. Tolerance of tube diameters guaranteed less than 0.0005".

5. All parts finished in satin chromium.

6. New low prices.

7. Panel mounting brackets furnished without extra charge.

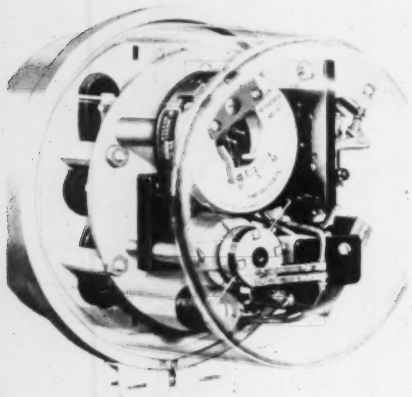
F & P rotameters measure rate of flow of any liquid, vapor or gas from "faucet drip" to hundreds of gallons or cubic feet per minute. This includes all alkalis and any acid. Even HF can now be metered with a rotameter specially designed for this Service. Their only moving part is a top-shaped float which rises in a tapered tube as flow increases. Position of float indicates rate of flow. Capacity scale is etched directly on tube. Remote recorders and integrators can also be furnished.

"Always be sure it's an **F & P** Rotameter"

Fischer & Porter Co.
115 West Penn Street
Germantown, Philadelphia, Pa.

Control Relay

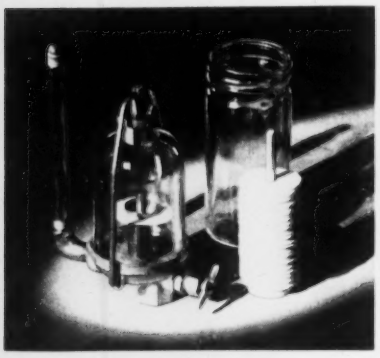
New "Microtrol Model 726" relay is said to constitute the first completely automatic self-contained ultra-sensitive controller. Input relay ("Model 705") will operate on values from 2 microamps. up and from 0.5 milli-



volt up; contacts of power relay ("Model 712") will safely handle 5 amps. at 110 volts a.c. non-inductive. Therefore, relay is suitable for smoke-alarm or liquid density control, a-c. and d-c. voltage or current alarms, over- or under-temperature or thermocouple failure, etc. Housing is a plug-in type glass case, similar to that of watthour meters, permitting removal of working mechanism without disconnecting any wires. Microtrol relay is designed for an operating interval in which power relay will open and close once each 1 secs. Relay will remain closed approx. 3 secs. and open 1 sec. These time intervals can be changed, on special order, so that device will close once each 15 secs., once each minute, or remain closed continuously until conditions return to normal. Microtrol relay is available in same ranges as the "Model 705," is intended for use on 120-volt 60-cycle circuits. For special requirements, it can be supplied for any commercial frequency, at voltage ranges from 12 to 250 volts. *Weston Electrical Instrument Corp., 591 Frelinghuysen Ave., Newark, N. J.*

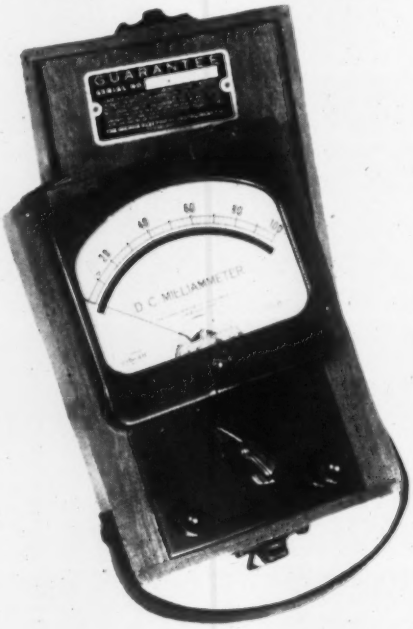
H_2S Tester

New Smyly H_2S Tester uses specially-prepared dry paper test disks, pre-treated with required amount of lead acetate. These disks are said to react to ¼ grain H_2S per 100 cubic feet of gas in one-minute test,



are furnished by the manufacturer on a spool in air-tight glass container, can be kept indefinitely. Tests can be made in one minute. Disk is slipped into glass chamber, gas turned on. After test, disk is dated and filed for permanent record. New device is reported to be practical for installing at outlet of each purifying box at gas plant and in the superintendent's and manager's offices. *Connelly Iron Sponge & Governor Co., 1153 So. California Ave., Chicago, Ill.*

POCKET PORTABLES



WATTMETERS—A.C. and D.C.
MICROAMMETERS, MILLIAMMETERS
AMMETERS, MILLIVOLTMETERS

Multiple ranges. Highest accuracy special portable movements. Send for new portable catalog.

The Hickok Electrical Instrument Co.
10514 Dupont Ave. Cleveland, Ohio

New DU MONT ELECTRONIC SWITCH and Square-Wave Generator

● Many features not in previous instruments. Switching rate approx. 6 to 2000 times. Handles extremely low or high frequencies. Permits displacement of patterns of simultaneous phenomena for close observation of each. Square-wave generator, 60-400 cycles.

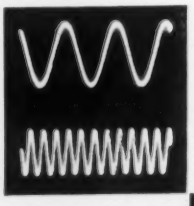
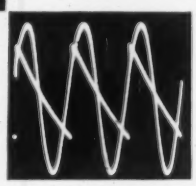


Photo showing comparison of two harmonically related signals on one oscillograph, using electronic switch. Patterns displaced for individual observation.

Independence and freedom from interaction of two channels shown in this photo. Illustrates ability of unit to handle sawtooth and sinusoid at same time and to make them appear as one oscillograph screen.



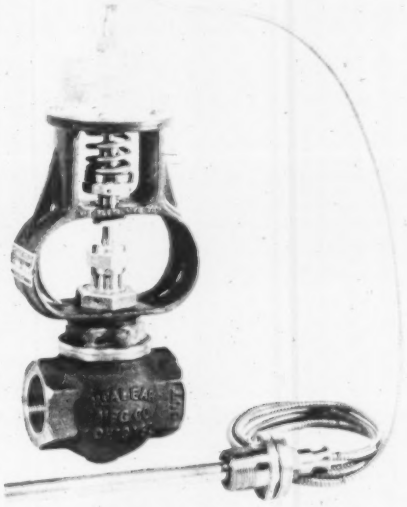
Write for DATA . . .

Technical details contained in special bulletin, sent on request. Consult Du Mont regarding your cathode-ray problems.

ALLEN B. DU MONT LABORATORIES, INC.
PASSAIC • NEW JERSEY

Self-operating Type Temperature Controller

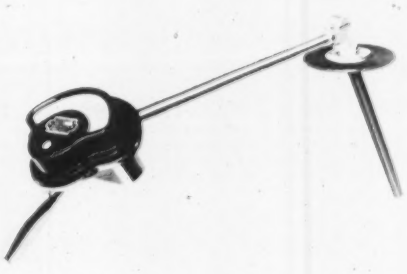
New "No. 3100 Temperature Regul[ator] is announced in twelve stock ranges of [adjustability,] from 75-115 to 220-260, [with] valves from ½" to 4" in various mate[rials.]



screwed or flanged ends, and with a choice of bulbs and connecting-tube materials and armors. Regular valves are described as "nearly balanced," hence suitable for ordinary steam-heating and brine-cooling pressures. High-pressure valves are available also. For extreme conditions of high pressure or large pipe sizes, the "3100" in a small valve size is used as a relay type controller commanding a suitable d-m valve of which a choice is available. *The Mason-Neilan Reg. Co., 1001 So. Western Ave., Chicago, Ill.*

Immersion Pyrometer

New "FerroTemp" has been developed for measuring temperature of molten iron and white iron by immersing thermocouple 1¼" outside diam. and 19" long. Depth of immersion does not affect accuracy. Thermocouple life is said to be better than 100 immersions. All couples receive a stabilizing treatment. Iron and slag will not adhere to



the couples. Instrument indicates maximum temperature 15 seconds after immersion of couple. "FerroTemp" is available in portable type (illustrated) and stationary type wherein a flexible extension lead connects the couple to a wall type pyrometer said to be readable at a 50-ft. distance. Portable model's instrument has non-breakable crystal, 6" temperature scale, 1600 to 3200° F range in 20° divisions allowing estimation to 10°. Portable model weighs 8 lbs.; over all length 47". Stationary model's instrument may be a recorder. *Harry W. Dietert Co., 9330 Roselawn Ave., Detroit, Mich.*

NEW

Wheelco "No-Contact"

INDUSTRIAL INDICATING CONTROL THERMOMETER

Wheelco "No-Contact" principle affords instantaneous reaction and far superior control to any other known method. For use in non-corrosive media and temperatures up to 1000 F., although applicable to any medium if suitable bulb protection is provided.

Literature on request

Wheelco Instruments Co.
1933 So. Halsted St. Chicago, Ill.

Metering Steam for

Bigelow-Sanford . . .

Here's how the Bigelow-Sanford Carpet Company of Thompsonville, Connecticut keeps an accurate check on steam flow. This is one of the many Cochrane Flow Meter installations that are daily saving power plants thousands of dollars through the accurate recording of steam flow.

Distinguished for extreme accuracy and high quality, Cochrane Flow Meters are reliable guides for compiling records of consumption, intake, output and variation in the rate of flow of steam, gases, water and other liquids.

Write for Publication 2096

COCHRANE CORPORATION
4120 N. 17th St. Philadelphia, Pa.

COCHRANE
FLOW METERS

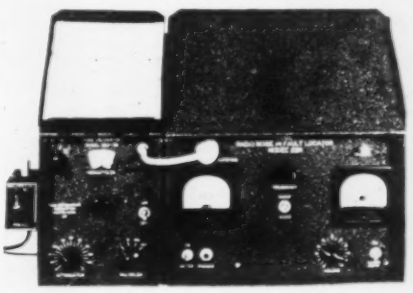
Pneumatic Telemetering System

Developed primarily for attaining utmost accuracy in centralized instrumentation regardless of distances from measuring points to control room, new pneumatic telemetering system known as "Metric Air-actuated

Remote Recorder and Controller" provides also complete safety where hazardous liquids and gases are present. Transmitter (illustrated) is maker's pressure or differential gage equipped with spring-loaded bellows and Metric Pilot Valve so related to measuring element that the transmitting-medium pressure is a function of the measured pressure or differential. Transmitting medium is air or gas under relatively low pressure (approx. 19 lbs. for maximum scale reading). Receiver is maker's recorder or "recorder-controller" with spring-loaded bellows at back of case. Transmitter and receiver bellows are matched and calibrated. Connection is by ¼" or ⅜" copper tubing, "any distance."—*Ingersoll Meter Co., Inc., 60 E. 42nd St., New York City.*

Radio Noise Locator

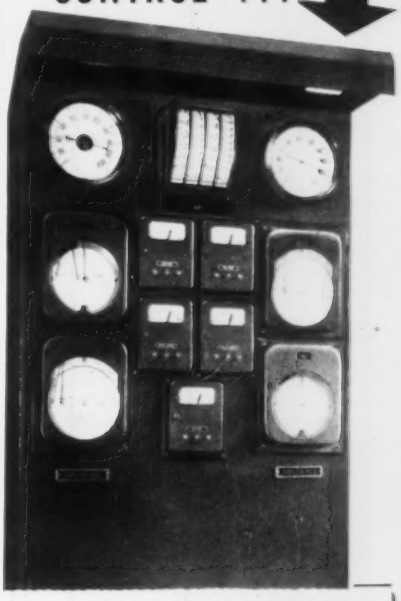
New "Model 239" Radio Noise & Fault Locator is said to be not only sensitive to all radio noises in the 500 to 1500 kc. band, but also to noises somewhat below this



band. Unit is housed in a welded steel case 12" × 12" × 7½". Weight including batteries is less than 28 lbs. A collapsible rod antenna for mounting on the Locator or outside automobile in which it is used provides non-directional pick-up.—*Tobe Deutschmann Corporation, Instrument Div., Canton, Mass.*

HERE'S *Hays*

CENTRALIZED COMBUSTION CONTROL . . .



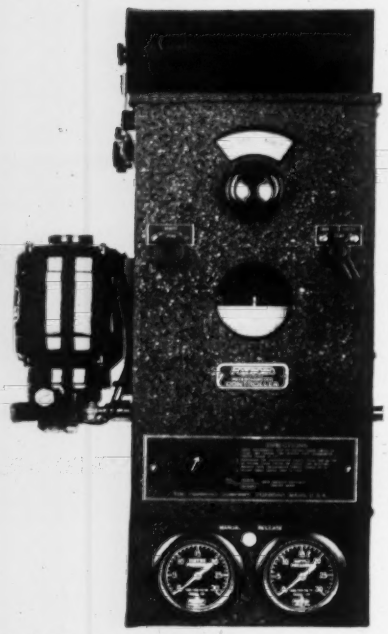
HAYS is the one truly CENTRALIZED control system—All of the control and measuring instruments are contained in one panel. Here is concentrated all information necessary for an intelligent understanding of what is going on inside the furnace, boiler and steam lines. And from this central panel the entire control system or any individual part of it may be operated manually.

Hays Centralized Combustion Control is offered through capable engineering organizations located in all principal cities of the U.S.A. and Canada. Correspondence is invited. Send for our 40-page catalog. Write to 925 Eighth Avenue, Michigan City, Indiana.

The HAYS CORPORATION
COMBUSTION INSTRUMENTS AND CONTROL
MICHIGAN CITY, INDIANA, U.S.A.

Air-operated Control Potentiometers

For applications where simplicity and other characteristics of pneumatic control are required together with responsiveness and accuracy characteristics of electrical temperature measuring methods, new temperature control system combines maker's potentiometer controllers (*Instruments*, Dec. 1933, page 231; Jan. 1934, page 14; March 1934, pages 52-54), air-operating system and diaphragm-motor valves (June 1934, page 125; Feb. 1936, page 51; April 1936, page 96). In new instrument, "knife edge" is said to respond to galvanometer deflection of 0.002", which may represent 1.3°F. Direct setting of 12" scale is possible to 0.2% of scale range. Available ranges are from —300°F. to 2800°F. By means of an automatic safety shutoff, instrument automatically puts valve in "safe" position if thermocouple circuit is accidentally opened. Air control mechanism is of positive open-and-shut type; recommended air pressure is 17 lbs. in.^{2}; valves are available in single- and double-seated balanced types.—*The Foxboro Co., 36 Neponset Ave., Foxboro, Mass.*



Radio Tester

"Rider Chanalyst" in rack and panel assembly is ready for installation with other bench equipment. All jacks are in front, immediately accessible. "Chanalyst" is designed to provide a rational method of approach in diagnosis of troubles, regardless of make of receiver; passage of signal is traced through receiver from antenna to loudspeaker. "Chanalyst" provides means of determining where the signal becomes distorted, takes on hum, or dies, without interfering with normal operation of receiver. Steel rack and panel is standard size, 19" × 12".—*Service Instruments, Inc., 211 Fourth Ave., New York City.*

PHOTRIX ELECTRONIC TIMER

AN ELECTRONIC TIME DELAY RELAY FOR INTERVALS FROM 1/10 TO 100 SEC.

No clockwork or motor, no re-setting for timing the same interval
A compact portable unit that requires no installation
To be operated by push button or by remote control

Size: 6¾ x 3½ x 4½ Weight: 3¾ lbs.

MOD. 822 A, 800 WATT, A.C. $37.50
Other models for D.C., for 1500 W. etc. slightly higher.

DR. F. LOEWENBERG
10 E. 40th St. New York City

WELCH
MASTER
PORTABLE INSTRUMENTS
Alternating and Direct Current

Fully Shielded — Accuracy ½ of 1% of full scale—Arc Length 5 inches—Mirror Scale—Attractive black bakelite and metal case—Available in a wide range of capacities.

W. M. WELCH
SCIENTIFIC COMPANY
Established 1880
1515 Sedgwick St. Chicago, Ill.

Vibration-proof Model of Pyrometer Controller

In new vibration-proof "Model V Celectray Indicating Potentiometer," photoelectric protection of galvanometer mirror retains practically instantaneous response of original model (*Instruments*, March 1934, pages 58-59; Nov. 1934, page 245; Apr. 1937, pages 95-96; Dec. 1937, page 298), but new damped photoelectric circuit does not respond to abnormal disturbance of light-beam. Thus Model V acts somewhat as a vibration filter, in that action of vibration upon galvanometer cannot effectively be transmitted through instrument to control device such as a magnetic contactor. Controller can be mounted rigidly in a vibrating panel along with contactor. It is said that vibration neither causes primary relay within instrument to operate, nor interferes with normal action of controller. Retained features of previous models include: safety shut-off, 15" scale, 0.1% accuracy and indications by white, red or green line of light on ground-glass.—*C. J. Tagliabue Mfg. Co., Park & Nostrand Aves., Brooklyn, N. Y.*

Valve Positioner

New pneumatic valve positioner for use on diaphragm-motor control valves overcomes effect of friction in the valve stem and top, is recommended particularly for installations where there is considerable process lag, is said to afford closer control in all air-operated applications by assuring proportionate valve stem travel for any change in air pressure from the controller.—*The Bristol Co., Waterbury, Conn.*

Vacuum . . . Thermocouples

COMPLETE LINE

embodying many unique features

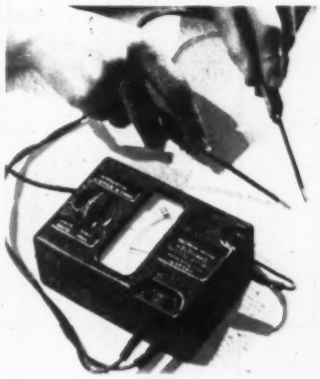
★

- DEPENDABLE STABILITY
- MORE EFFICIENT
- HIGHER OVERLOAD
- FASTER RESPONSE
- SMALLER SIZE—½"x1"
- LOWER COST

These thermocouples will meet the most rigid specifications. Prompt delivery is assured. Write your requirements to:

AMERICAN Electrical Sales Co., Inc.
67 E. 8th St. New York, N. Y.

MIDGET "MEGGER" CIRCUIT TESTING OHMMETER



Independent of Battery Voltage
Ranges—from .1 ohm up to 200,000 ohms

Quite different from a voltmeter calibrated in ohms, this direct-indicating "Megger" Ohmmeter requires no adjustment for the voltage of the battery that supplies current for the test. The instrument is a true ohmmeter of the "Megger" cross-coil type. For laboratory, shop and portable use for checking coils, resistors, contacts, windings, circuits, relays, etc., and even insulation resistance up to 200,000 ohms. Molded case, mottled green in color. *Write for descriptive Bulletin 1495-I.*

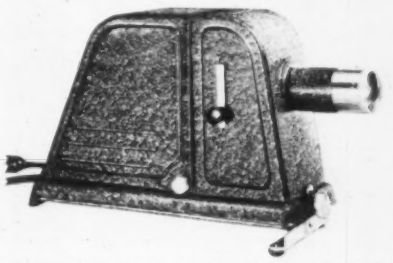
JAMES G. BIDDLE CO.
ELECTRICAL INSTRUMENTS
1211-13 ARCH STREET PHILADELPHIA, PA.

Rotameters for HF

Hydrofluoric acid and other fluorine compounds can be metered by means of a new series of Rotameters (free-float type flowmeters—see numerous items in previous issues) in which the calibrated tube is made of a suitable transparent material other than glass. Indicating rate-of-flow meters are immediately available from stock; recorders, controllers and telemetering systems are in final-development stage. *Fisher & Porter Co., 117 W. Penn St., Germantown, Philadelphia, Pa.*

Slide Projector

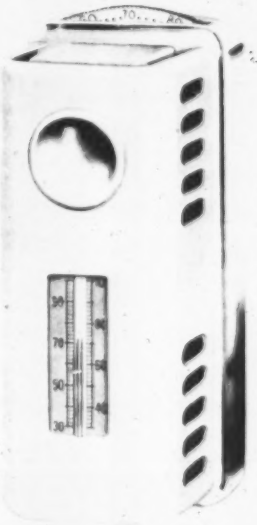
"Model MK Delineascope" is a 100-watt projector for 2" x 2" slides supplementing (and simpler than) 750-watt auditorium projector "Model GK." *Instruments*, Dec. 1938, page 289). Makers claim that it remains cool enough to handle at all times and assures safety for color films. Spencer projection lens is 5" focal length, speed f:3.6. Slides are placed in conventional-type all-metal carrier. Self-leveling elevating device is held by thumb-screw. Hinged lamp housing affords easy access to lamps and condensers. *Spencer Lens Co., Buffalo, N. Y.*



Non-Inductive Power Resistors

New wire-wound inorganic-cement-coated non-inductive power resistors have non-inductive characteristics satisfactory up to 30 Mc.; are available in wattages from 10 to 80, and in all popular resistance values. Applications include measurement of actual transmitter output and tuning of antenna systems and transmission lines without going on the air with interfering signals. *Clarostat Mfg. Co., Inc., 285-7 N. 6th St., Brooklyn, N. Y.*

Electric Contact Type Temperature Controls



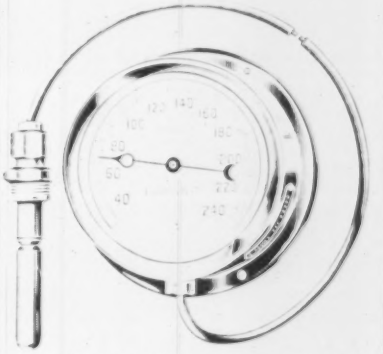
New high-voltage room thermostats, oven controls and space thermostats operate on "Hydraulic Action" liquid-filled thermal systems actuating switch contacts carrying up to 25 amps. at 120 volts a.c. Beside room-type illustrated, others are available for industrial applications. *Julien P. Friez & Sons, Baltimore St. & Central Ave., Baltimore, Md.*

MOELLER PRECISION GRADE INSTRUMENTS

★

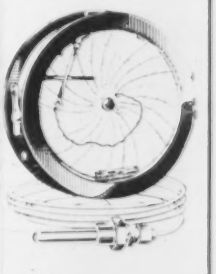
Our mercury thermometers are made with the Moeller Glass Red Reading Column which makes them easy to read under varying light conditions, at a considerable distance and over a wide range.

★



Moeller dial thermometers are made in various scale ranges up to 1000 F. or equivalent in both Metal and Phenolite cases.

Moeller recording thermometers are likewise furnished in various ranges up to 1000 F. or equivalent in both round and square cases.



Other products include

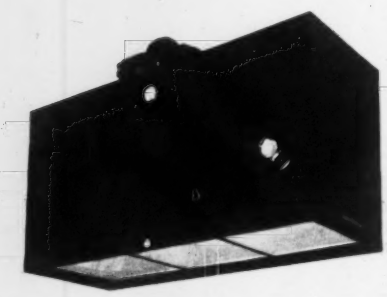
HYGROMETERS
RECORDING PSYCHROMETERS
BAROMETERS HYDROMETERS
MARINE INSTRUMENTS, ETC.

Write for catalog.

MOELLER INSTRUMENT COMPANY
132nd STREET and 89th AVENUE
RICHMOND HILL NEW YORK

Color-matching Light-source

New "Model BKX-82" is an air-cooled illumination unit delivering "north-sky daylight" approximating National Bureau of



Standards' specifications, or "horizon-sunlight" (said to be a magnification of ordinary artificial light). Either quality of illumination is produced at a relatively high level of intensity, diffused over a relatively large area.—*Macbeth Daylighting Co., 237 W. 17th St., New York City.*

Automatic Inspector for Solder Pellets in Cans

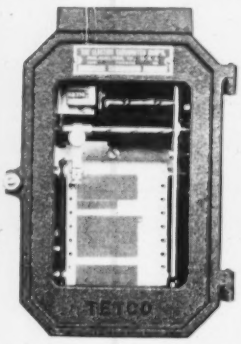
Inspection equipments, "RA-252" for "tall" cans and "RA-255" for "baby" cans, have been developed for automatically rejecting cans which contain solder pellets introduced in sealing process. Each equipment consists of an acoustically insulated tunnel containing a track forming part of can conveyor system. Okay cans roll through tunnel and continue normally. When a can containing a pellet rolls into tunnel, pellet rattles; a microphone at the center of tunnel detects this noise; electrical wave filters tuned to pellet noise aid tunnel's acoustic attenuation in preventing operation of equipment by plant noise; amplified pellet noise operates solenoids which open a section of the track, dropping cans containing pellets. Rejected cans, in falling out through a reject chute, actuate a switch which restores equipment to readiness for next can. Electrical equipment is housed in control cabinet installed at any convenient point near track assembly. An auxiliary relay can be used, if desired, to operate a light signal when a can is rejected. Inherent stability of moving-coil type microphone and feedback type amplifier obviates need of daily calibration or adjustment despite normal variations in line voltage or vacuum tube condition. Under usual conditions, approx. 160 cans per minute can be handled. Equipment operates from 115-volt 60-cycle single-phase supply.—*Electrical Research Products, Inc., 195 Broadway, New York City.*

Computing Scale

New and improved model of "Automatic Allmail Computing Scale" is—"Model 14" equipped with twin-pendulum gravitational system and compound levers. Indicator of knife form and platform location in front of dial combine to prevent parallax errors from angle reading. Sensibility, though not stated quantitatively (this is primarily a postal scale—not a laboratory balance) can be inferred from reference to combination of "accuracy" and "sensitivity" as better than ½ oz.—*Pitney-Bowes Sales Co., 1449 Merchandise Mart, Chicago, Ill.*

TETCO

Speed Recorder



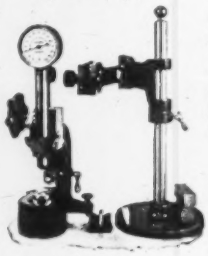
Creates a permanent time record on a waxed chart. Accurately records rate of production, time and duration of stops, total quantity produced.

The Electric Tachometer Corp.

1358 Spring Garden St., Philadelphia, Pa.

HARDNESS TESTING...

done WITH NO MENTAL HAZARDS. The SCLEROSCOPE has done it for the past 30 years.



In general use for specification purposes. Simple, sturdy. Comparatively inexpensive.

Illustrated bulletins free.

The Shore Instrument & Mfg. Co., Inc.

9025 Van Wyck Avenue, Jamaica, N.Y.

★ *NATIONAL* ★

RHEOSTATS

Ask for Catalog No. 5

National Electric Controller Co.

5317 Ravenswood Ave., Chicago, Ill.

Is this YOUR copy of *Instruments?*

See page 87

A & A COILS

Magnet *Established 1924* Solenoid

Electrical Coil Winding Co.

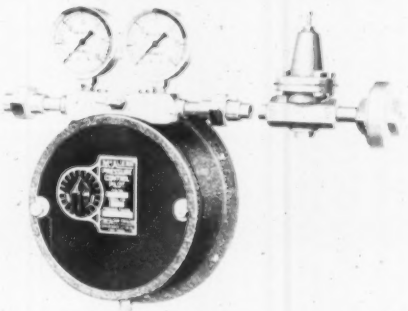
2736 Saunders St., Camden, N. J.

Inkless Recording Instruments

Initial series of recorders employing pen-writer ribbon as marking medium (*Instruments*, Feb. 1938, page 65) has been [illegible] to a complete line, designated as "Type CF-1," comprising recording single- and double-range a-c. ammeters and voltmeters. Improvements make possible continuous operation for 30 days without attention, at temperatures as low as —10°F and as high as 120°F. New units are in the low-price range, suited for voltage surveys, complaint investigations and checking circuit load conditions. Although portable, they may be wall- or pole-mounted. Voltmeters are listed for double range of 0-140/0-280 volts. Ammeters are for 0-5/0-10 amperes. Single-range instruments can be supplied. Voltmeter is accurate to 1.5% of full-scale value over normally-used range: 110 to 130 and 220 to 260 volts, and to 3% outside those limits. Ammeters are accurate to 3% of full-scale value. "Type CF-1" recorders weigh 11 lbs., measure 10-9/16" high, 8-9/16" wide, 5-21/32" deep. Chart is 4" wide (3½" record space), is driven by a Telechron motor at 1", 2" or 3" per hour. A second Telechron motor operates inkless mechanism. Burden on instrument transformers is 1 va. for the 5-amp. ammeter or the 110-volt voltmeter at 60 cycles.—*General Electric Co., Schenectady, N. Y.*

Air-operated Type Pressure Controller

New "Pressure Control Pilot No. 97" is designed to command maker's or other diaphragm-motor valves for control of either discharge or back pressure. Primary element



is a Bourdon tube; pilot is of nozzle-and-flapper type. There are two adjustments—speed of response, and throttling range. Gages, filter and pressure regulator for compressed-air supply are regular equipment. Regulator is not needed where 18-20 lbs./in.² supply is already installed. Several models are offered, with corrosion-proof or "ordinary" Bourdon tubes, and for "any working pressure desired."—*The Wm. Vogt Mfg. Co., 1901 So. Western Ave., Chicago, Ill.*

Push Button Tuner

By means of a two-deck arrangement [illegible] oscillator and antenna condensers of new "CX-52" Push Button Tuner are adjusted with a single screw, improving accuracy and stability. Work of tuning to desired stations is facilitated. Use of two-circuit receivers for push button tuning is made possible. The two-deck strips may also be used in conjunction with permeability coil-tuned or trimmer-tuned oscillator circuits for three-circuit receivers, requiring two adjustments. New tuner is made in front- and back-adjusted types, up to six station buttons and with any ordinary switching arrangement. In addition to single-screw arrangement for antenna and oscillator capacitors there is a small vernier adjustment screw on antenna capacitor to enhance accuracy in difficult cases.—*Sprague Specialties Co., North Adams, Mass.*

TEST MAGNETIC PROPERTIES OF YOUR STEELS

RAWSON FLUXMETER

SIMPLEST AND MOST EFFICIENT
Bulletin 504

Dynamometers, wattmeters, milliammeters and voltmeters. Also ultra-sensitive meters both for A.C. & D.C., fluxmeters, electrostatic voltmeters from full scale 120 volts to over 20,000 volts, thermocouples, earth current meters, cable testers, etc.

Acknowledged leaders in development of high sensitivity meters

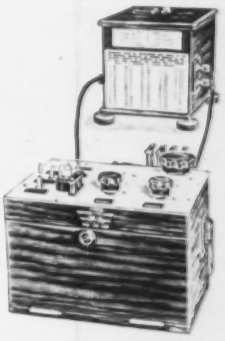
Rawson Electrical Instrument Company

110 POTTER ST. CAMBRIDGE, MASS.
Branch: 15 East 26th Street, New York City
Representative: E. N. Webber
1313 W. Randolph St., Chicago, Ill.

Multiplier for 20,000 Ohms-per-volt Analyzer

New multiplying unit designated "Televerter" extends the range of 20,000 ohms-per-volt analyzers to 5,000 volts, for television servicing, etc. Unit consists of a resistor tube, two test leads, prods, and a mounting clamp. Maximum current drain is 50 μa., with an input impedance of 100 megohms on top range. Multiplier is sealed and protected against humidity as well as mechanical damage; has a relatively low temperature coefficient; can readily be adapted to various models of analyzers, such as maker's Models 772 and 765; is equipped with binding posts to make it adaptable to future models of analyzers; fits into carrying compartment of Model 772 Analyzer.—*Weston Electrical Instrument Corporation, 591 Frelinghuysen Ave., Newark, N. J.*

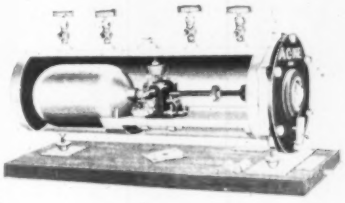
Evelyn
PHOTOELECTRIC COLORIMETER



A single-photocell, direct-deflection photoelectric photometer equipped with light filters. Highly useful in quantitative analysis wherever changes in the concentration of a constituent can be translated into corresponding variation in the color intensity of a solution. Described in Bulletin 460, a copy of which will be sent upon request.

RUBICON COMPANY

Electrical Instrument Makers
29 N. 6th Street Philadelphia, Pa.



The AC-ME Gas Gravity Balance

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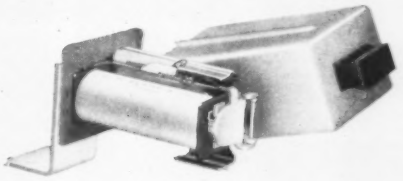
New "Type SL" spring-loaded pump governor, designed especially for service on steam-driven reciprocating pumps or on centrifugal pumps driven by small steam turbines, is suited for excess-pressure service in boiler feeding where max. excess pressure does not exceed 75 lbs.; may also be used for constant-pressure service where controlled pressure is not to exceed 75 lbs.; is furnished in sizes from ¾" to 3", in the 250-lb. and 300-lb. standards only. Actuating element, a 4-ply brass sylphon bellows, is protected against water hammer, etc., by a stabilizer.—*Northern Equipment Co., Erie, Pa.*

A-c. Relay

Among claimed features of new "Type A" a-c. relay are: "low-loss" magnetic circuit, quick action, no "contact bounce" or chatter, and numerous contact arrangements. Contacts available are silver, palladium, platinum-iridium and tungsten welded to springs, and in various sizes up to 3/16" diam.—*C. P. Clare & Co., Lawrence & Lemon Aves., Chicago, Ill.*



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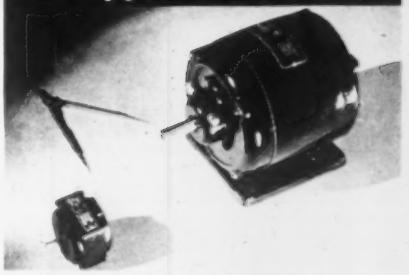

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Whatever your requirements, there is a Bodine motor to fit the job. The Bodine line includes split phase, capacitor, and polyphase induction and synchronous a-c motors; shaded pole a-c motors; shunt and compound d-c motors; and series universal motors. Also speed reducer and governor controlled motors. The finest instruments are Bodine equipped.

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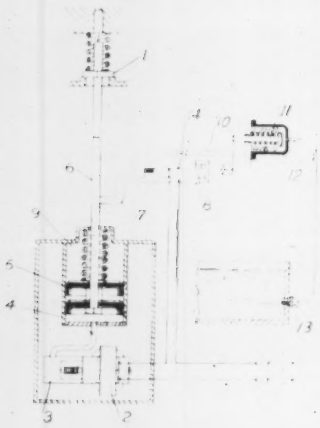
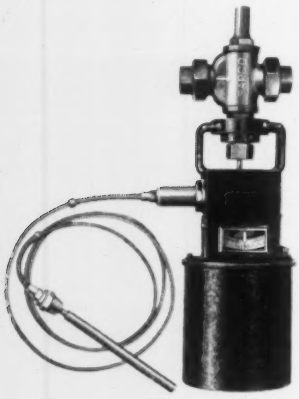
In new "Type SE" Temperature Regulator, function of thermal system 13-11 is to position lever 10 which determines actuation point of limit switch 8. Thus, thermal system is not required to do mechanical work.



Valve 1, normally (main switch off) closed, is opened by piston 5 moving up cylinder 4 under pressure of oil pump 3 driven by motor 2. Spindle 6 continues up until arm 7, attached to it, brings normally-closed limit switch 8 against finger 14. When 8 opens, motor 2 stops, oil pressure under 5 is relieved and valve starts moving toward closed position, eventually adjusting itself to a position between wide-open and closed.



Cyclic oscillation is the mode of control—designedly so, for purpose of finger 14 is to provide an adjustable lever arm and hence an adjustable response of entire system, whereby cyclic characteristics of controller and of controlled apparatus can be matched to give critical damping and prevent hunting. "Type SE" is suitable for temperatures between —40° and 650°F.; each controller being adjustable in the field for 50° higher or lower than its factory calibration point specified by user.—*Sarco Co., Inc., 183 Madison Ave., New York City.*

Eight-watt Amplifier

Said to be "unusually versatile," new 8-watt Thordarson Amplifier "T-20WOS" comes in metal screen cover, or in portable combination speaker and carrying case of base reflex type, said to be unique in small portable amplifiers. Amplifier proper is of 4-tube beam power type with individual control of mike or phone for complete mixing, supplies 6 watts of power for field excitation, has provision for selecting output impedances.—*Thordarson Electric Mfg. Co., 500 W. Huron St., Chicago, Ill.*

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High-speed Engine-pressure Indicator

New high-speed engine-pressure indicator of balanced diaphragm type is designed for use in mapping indicator diagrams of high-speed internal combustion engines, or other machines in which gas pressures occur in successive cycles of same form, cards being

obtained by a point-to-point method that gives average of a large number of engine cycles. Principle employed is balancing of engine cylinder pressure against a measured pressure on opposite sides of a metal diaphragm of negligible stiffness. Phase of engine cycle to which a pressure measurement corresponds is selected by a timing device. Indicator can be used successfully at speeds up to 3000 r.p.m., and for pressures from 10 lbs./in.² below atmospheric to 1500 lbs./in.². Indicator outfit consists of: (1) pressure-balancing element, screwed into cylinder like a spark plug, (2) timing element, fastened to a rotating part of engine, and (3) the coördinating, measuring and recording apparatus, located conveniently and connected by means of wires and flexible pressure tubes.—*American Instrument Co., 8010 Georgia Ave., Silver Springs, Md.*

High-voltage Indicator

New "Hi-Volt Indicator" is equipped with a clip for carrying in vest pocket ready for use. Glow tube flashes in a changing static field: no need to touch conductor. Device gives positive indication on 2000 volts and up, it "several times the flashover distance on non-insulated conductors."—*Ideal Commutator Dresser Co., Sycamore, Ill.*

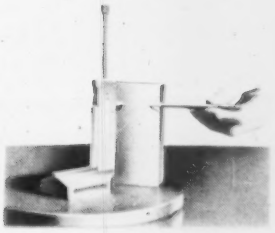
Gage Pointer Tool Kit

For removing and resetting pointers or hands on pressure gages, new set of tools known as "Marshalltown Duplex Hand Jack and Pointer Driver," come in all-metal box

smaller than a cigarette package. Duplex handjack fits pointers on gages from 2" to 16" dial size, is two handjacks; one slit for small pointers, other for larger sizes. Driver is designed for resetting the pointers. Flat sides of handjack serve for tapping pointer on pinion shaft.—*Marshalltown Mfg. Co., Marshalltown, Iowa.*

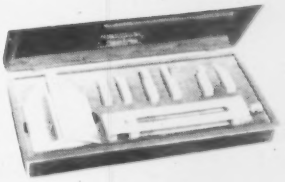
JOHANSSON ACCESSORIES INCREASE THE USEFULNESS OF JOHANSSON GAGE BLOCKS

Your Johansson Blocks, used with an Adjustable Holder, a Scriber and Center Point, enable you to scribe an arc.



The Scriber and blocks in Holder with Foot Block draw lines at a given distance above a plane.

A set of jaws with blocks will measure diameter, inside or outside. Jaws fit flat or convex surfaces.



These accessories can be purchased singly or in set No. 44, $65 with the case.

There are other accessories and larger sets. Complete information in Catalog No. 12. Write to

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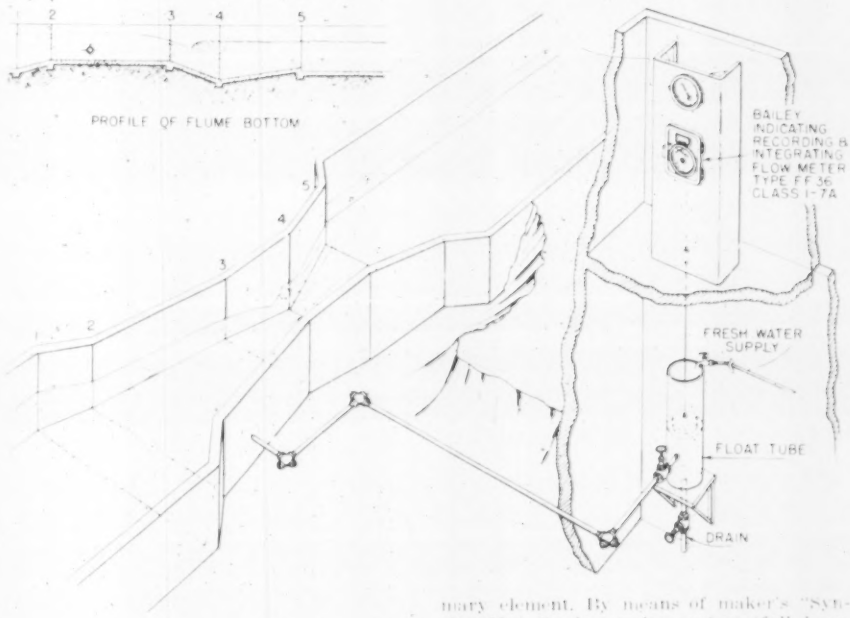
Meter for Measuring Flow Through Open Channels

For measuring the flow of liquids through open channels by the use of a weir notch or Venturi flume, new meter employs a float-operated device with float motion transmitted to indicating or recording mechanism through a cable, sheave, gear, and cam mechanism. By varying shape of cam and installing proper gears, it is possible to use this instrument with weir notches of all types, and with the Parshall Venturi flume. Flow record is given in terms desired on an 11"-uniformly-graduated chart; integrating mechanism registers total flow (gals., lbs. or ft.³) on a 6-digit cyclometer counter. Meter can be furnished with indicators of the dial or sector type. Illustration shows meter with Parshall Venturi flume as primary element. By means of maker's "Synchro-Meter" telemetering system (full descr., *Instruments*, May 1937, page 124), same mechanism can be used with receiver located remotely from the weir channel or Venturi flume; one mile away with No. 12 wire conductors. This system operates on 25-, 50- or 60-cycle a.c.—*Bailey Meter Co., 1041 Ivanhoe Rd., Cleveland, Ohio.*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Aircraft Navigator's Radio Receiver

Direct "finger-tip" control and economy of instrument-panel space characterize new "25A" radio receiver for all types of flying. All r-f. elements together with switches, dial and control knobs are grouped in one small unit mounted on instrument panel, while cabinet which contains all r-f. apparatus, etc., may be installed in after part of ship. By operating a rotary switch, pilot may select CAA beacon signals, weather reports, distress signals, regular Aviation Communication band, etc. Same switch gives pilot crystal-control on any two previously selected frequencies in Communication band. Navigational value of beacon signals being impaired by operation of a.v.c., this switch also automatically disconnects this circuit element when receiver is tuned to beacon band. Installation weighs 16 lbs. R-f., control-unit weighs 4 lbs. 3 oz., measures 7 ⅞" wide, 5-15/16" high, 4¾" deep.—*Western Electric Co., 195 Broadway, New York City.*

Parasitic-oscillation Suppressor

Ultra-high frequency parasitic self-oscillations at unwanted frequencies which occur in plate and grid leads of parallel or push-pull tube circuits, causing waste in useful output energy, as well as distortion, are prevented by inserting new "Type 13m Parasitic Suppressor" in grid lead at tube socket. Suppressor introduces negligible resistance at the fundamental frequency, has no effect on driving power needed, is a non-inductive vitreous-enameled resistor combined with a choke into one integral unit 1⅜" long overall and ⅝" diam., small and light enough to be inserted in lead without requiring any support.—*Ohmite Mfg. Co., 4835 Flournoy St., Chicago, Ill.*

Volt-ohmmeter

"Rider VoltOhmyst" is a new combination of d.c. voltmeter and general-purpose ohmmeter having a single range-selecting rotary switch as well as a single indicating instru-

ment, housed in a moisture-proof sloping-panel case. *Voltmeter* has nine ranges: 5/10/25/100/250/500/1000/2500/5000, does not require zeroing when changing ranges, has a polarity knob which obviates need of reversing leads. Freedom from contact potential errors is claimed. *Ohmmeter* has seven ranges in decades which have mid-scale calibration values from 10 ohms to 10 megohms so that (by virtue of deflecting-element scale law) total-range extremes are 0.1 ohm and 100 megohms. Circuit has been patented, is of push-pull type, is said to be highly stable. *Service Instruments, Inc., 342 Fourth Ave., New York City.*

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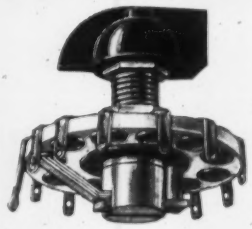

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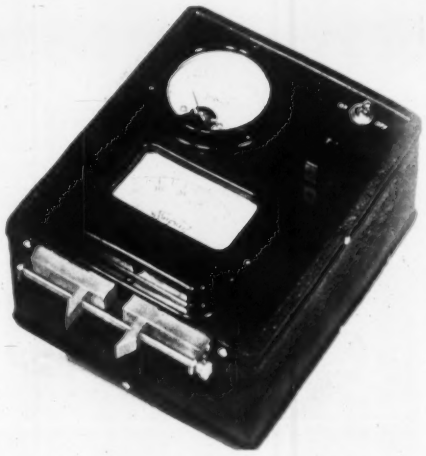
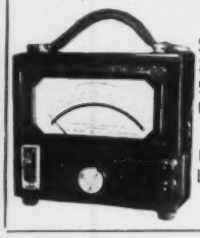


has a d'Arsonval movement without magnet. The magnet to be tested is placed in contact with protruding pole pieces, furnishing required field for instrument. Pointer moves across scale in accordance with the setting of the second instrument, a milliammeter, and indicates comparative strength of magnet being tested. Current passing through circuit is controlled by a rheostat. Variations of rheostat-milliammeter control make it possible to check magnets of different strengths. Magnetometer is furnished with fixed or adjustable pole-pieces, as required. Source of current is self-contained No. 6 dry-cell battery.—*The Triplett Electrical Instrument Co., Bluffton, Ohio.*

NEW "ALNOR" PORTABLE PYROMETER



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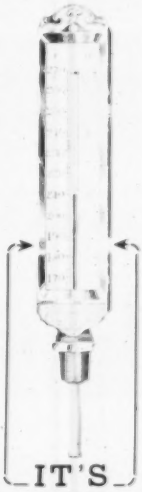

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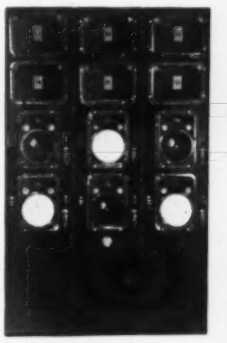

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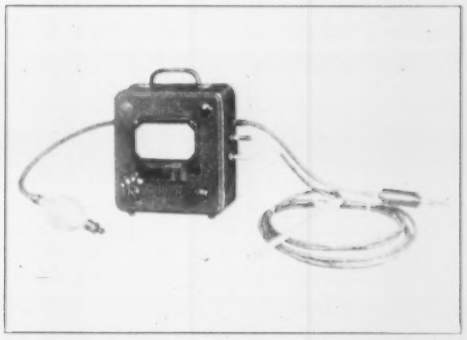

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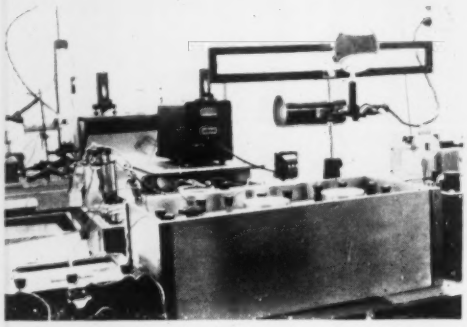

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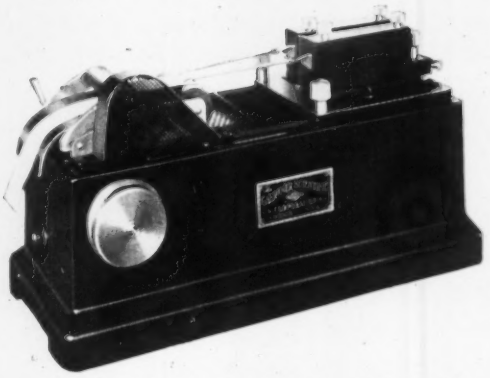

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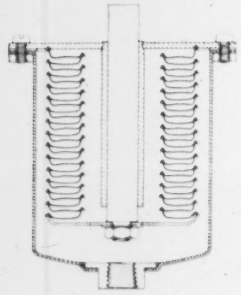

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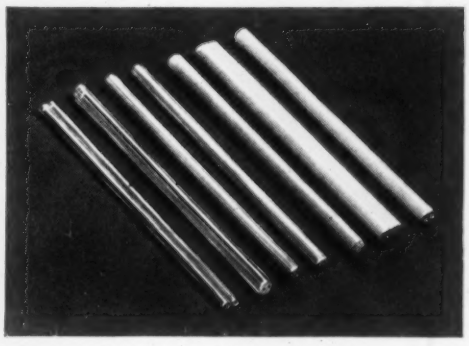

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Instrumentation of the Solvent Dewaxing Process

By G. C. THRIFT
The Texas Company, New York

IN the last few years the intensive development and commercial use of solvent refining and dewaxing processes have, on occasion, presented some interesting problems of automatic control. The Solvent Dewaxing Process,* originally projected for processing distillates, is now developed to a point where any type of wax-bearing petroleum product is processed, be it distillate or residue. It was reported recently in *World Petroleum* that some 62.7% of all the solvent dewaxed oil was handled by this process.

For those not acquainted with the process, it might be well to explain that the operation consists essentially in blending the waxy charge oil with solvent, then chilling to the proper temperature, usually about 0 to —15°F. when producing a substantially wax-free oil, then filtering out the wax, the separate wax-free filtrate and wax mix stream passing on to the solvent recovery unit before passing on to rundown tanks.

No special equipment is used in the process—with the possible exception of the double-pipe exchangers, chillers, and rotary pressure or vacuum drum filters, the changes here being only modifications of units already well-known to refiners.

Automatic control has contributed much to the uniformity of products and operations—even in some cases to lowering the overall investment. It has come to be regarded as a necessity as much here as to any of the modern processes.

Although no specialized controls are used, the use or method of installation of standard instrumentation items may, in some cases, be unique. For the purpose of our discussion, we shall divide the operating process into three parts: (1) the filtration unit, (2) the solvent recovery unit and (3) the refrigeration plant. Proper surge capacity is, of course, provided between the interconnected units. No particular problems are involved in the refrigeration unit, and it will not be discussed here.

Filtration Unit

In the filtration unit the solvent is pumped from the recovery unit, its flow being controlled by a system beginning with an orifice in the pump discharge and ending in a valve throttling the steam to the pump. A flow ratio control in turn keeps the speed of the waxy oil charge pump synchronized to maintain the proper solvent-to-oil ratio for best results. The solvent orifice is common to the flow control on the solvent stream and the primary side of the flow ratio control; the secondary orifice is located directly in the waxy oil charge line.

The viscosity correction on the waxy oil flow being in some cases appreciable, some difficulty would be expected in maintaining proper control of the solvent-to-oil ratios. For this reason the original installation was made with the secondary orifice in the solvent and oil mix line entering the first series of double-pipe exchangers. The control valve was placed on the steam to the oil charge pump, as shown in the flow diagram.

When processing high-viscosity oils the solvent-to-oil ratio is three or four to one and under these conditions the increase in volume due to the charge oil is only 20 to 25% of the recorded flow through the secondary orifice. Since the accuracy of the controller is a percentage of the total flow through this orifice, the actual error, when expressed in volume of charge oil, is automatically multiplied by four to five. The magnitude of this error is greater than a high-viscosity correction factor and the secondary orifice is placed directly in the viscous oil line. Where oils of a wide viscosity are processed, an orifice changing fitting is used as the secondary orifice to keep the oil flow pen in the higher range of the chart on low flow rates. These orifice fittings are calibrated in the early stages of operation and no difficulty is experienced.

The waxy mix passes on to the first series of double pipe exchangers where it is partly refrigerated by exchange with cold filtrate, the waxy mix being inside the pipe and the wax-free filtrate between the two pipes. The waxy mix passes on to the series of ammonia chillers, still inside the pipes with, in this case, the ammonia between the pipes. The outlet temperature is the final desired temperature at which filtration will be conducted. The exchangers and chillers are in multiple units depending on the size of the plant. In the usual design a maximum of eight or ten units in series is allowable before going to parallel streams through these units. In cases of parallel streams, the instrumentation is naturally somewhat different from that shown on the diagram and the parallel streams are controlled by individual rate-of-flow controls. The ammonia chillers in the series are equipped with liquid-filled thermal system type temperature controls with the control valves in the ammonia vapor line leaving the chiller. Only the temperature control on the last chiller is equipped with automatic-reset mechanism, all other temperature controls being of the wide-throttling-range type. Liquid-filled bulb systems are used here to obtain an appreciable pen movement at the control point, which in this case is on the low end of the chart range. The control valve on the last chiller is equipped with radiating fins and valve positioner. All others are equipped with radiating fins only.

The chilled wax and solvent mix pass on into the charge mix drum which is equipped with an internal wide-range ball type level recorder which records the level by means of a throttling type pilot connected to a 0-15 lbs. in.² pressure pen on the flow control on the primary solvent pump. A 0-15 lb. pressure gage may also be connected in parallel with this pen and located in the filter room for information of the operator. The charge mix enters this drum above the liquid level and the consequent turbulence makes it necessary to use a rugged type of shaft and float arm for mechanical strength. The pilot mechanism is adjusted for slightly less than 100% proportional throttling range to insure recording full range of the chart. This drum is also equipped with a high-level float alarm device (of either air-operated or explosion-proof electric type) sounding a small whistle or flashing a bull's-eye on the panel and also, in some cases, automatically closing the control valve on the primary solvent pump independently of the flow control at this point. This device is installed to avoid overflowing the drum from improper adjustment of the primary flow control or an interruption in filtration.

From this drum the wax oil mix flows to the filters by gravity, the level in the individual filters being controlled by narrow-throttling mellon or kidney type level controls operating a control valve in the feed. The initial installation demonstrated the superiority of butterfly valves for handling the waxy mix at this point, and they have been used since that time.

The operation of the filter produces wax-free filtrate and wax, both still containing solvent. The filtrate passes into the vacuum receiver and is pumped back through the double-pipe exchangers to recover refrigeration before passing on to the recovery unit surge tank. The filtrate pump is controlled with a rugged wide-range ball type float with straight throttling pilot.

The wax cake is discharged from the filter into a scroll conveyor and dropped into the wax mix drum in a creamy

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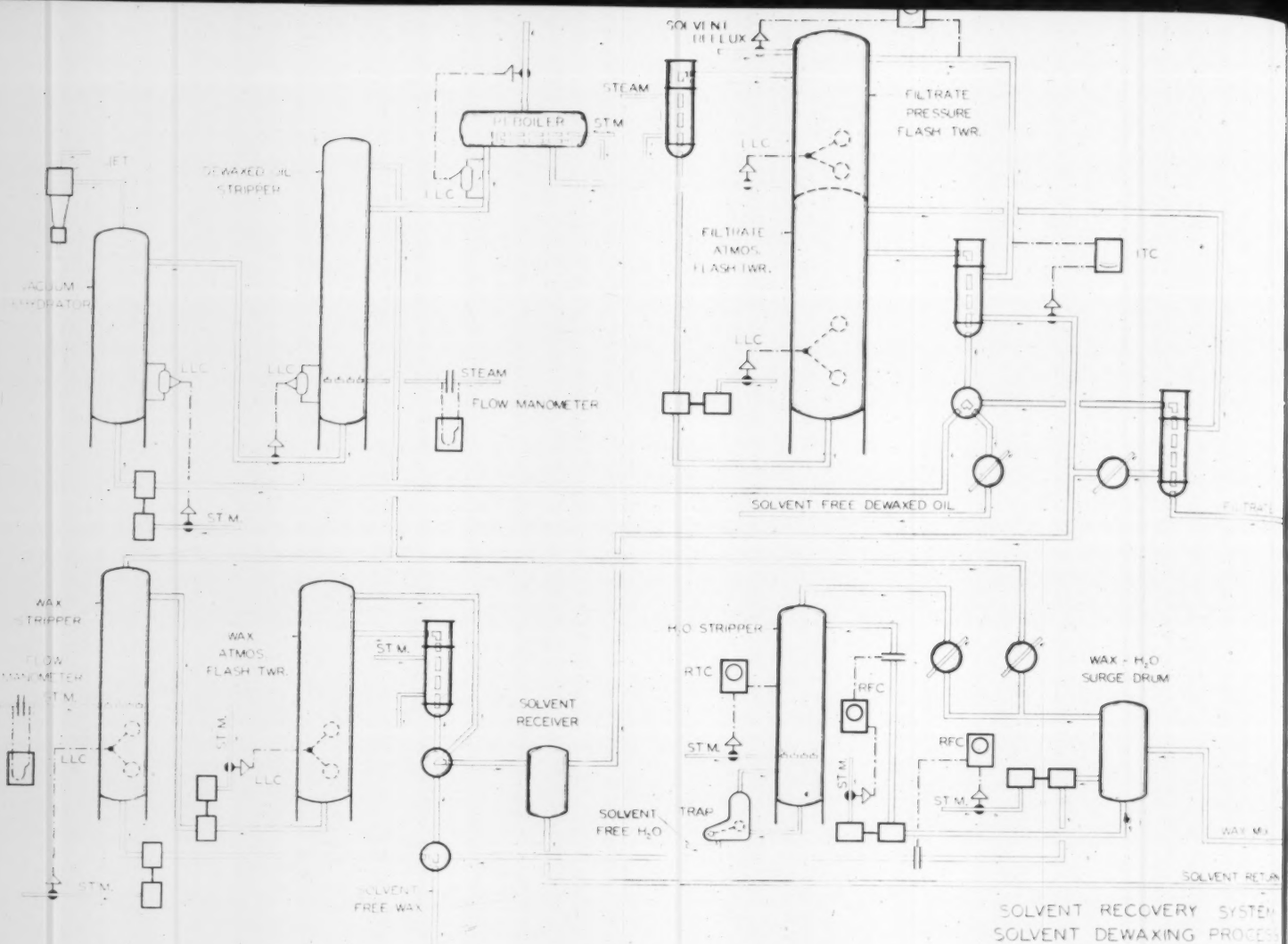


SOLVENT RECOVERY SYSTEM
SOLVENT DEWAXING PROCESS

liquid state, the crystals being "rushed" up by the normal mixing action of the scroll conveyor. This wax mix tank is equipped with a differential type level indicator of the mercury U-tube type, both differential leads being equipped with permanent solvent flushing connections.

The wax mix is then pumped through exchangers and a steam heater before passing on to the wax solvent mix surge tank at the recovery unit. The wax pumping rate is of little consequence and is ordinarily manually controlled; some of the future units may incorporate an internal ball float control to avoid routine attention.

The only other instrument type control in this part of the system is the temperature control on the shell and tube cold wash solvent chiller, this controller being of the same type and range as that used on the last double pipe ammonia chiller.

It might be well to point out here that ammonia type mechanical level controls gave some trouble on the earlier installations due to lack of power and mechanical weakness; these were replaced on the later units with air-operated mellon or internal type float controls with diaphragm valves on the ammonia feed. Radiating fins are used to protect the stuffing boxes of both the diaphragm valve and the level control.

The three important temperatures are the chilled wax oil mix, the cold wash solvent, and the cold flue gas, and are generally recorded on a resistance-thermometric system multi-point strip-chart recorder.

Solvent Recovery Unit

For clarity the solvent recovery unit is shown somewhat out-of-scale on the diagram, which is that of a plant processing slightly more than 1,000 barrels of waxy oil charge per day: where the additional heat recovery due to two-stage evaporation is justified.

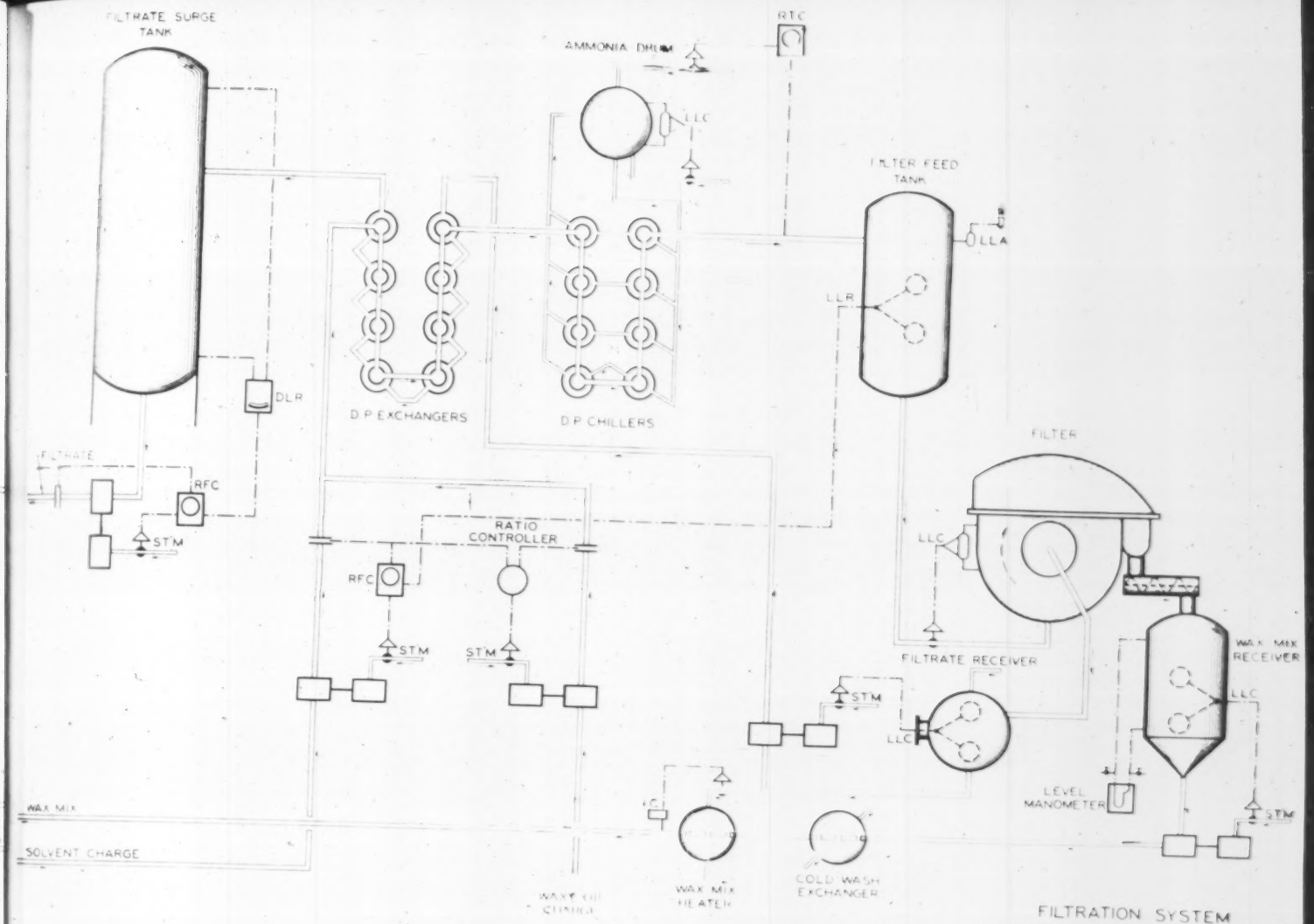
It will be noted from the diagram that the dewaxed oil-solvent mix or filtrate flows through the atmospheric vapor heat exchanger, then against the hot wax-free oil, then through the pressure vapor heat exchanger and flashes into the atmospheric tower where the major portion of solvent is flashed off; the liquid in the bottom of the tower being pumped through the high-pressure steam heater into the high-pressure flash tower. The liquid is then flashed to atmospheric pressure in a small kettle type reboiler before passing on to the steam stripper. The solvent-free oil may pass from the bottom of the stripper into a vacuum dehydrator to remove any trace of water before being pumped out, cooled, and on to rundown tank as dewaxed oil.

The wax system is shown in this case to be single-stage evaporation, the wax and solvent mix being heated to solution temperature before entering the surge tank shown. Bimetallic air-operated controls have proven satisfactory in controlling this heater. The wax and solvent solution is then pumped from the surge tank, exchanging heat with the finished wax, then on through the atmospheric vapor heat exchanger, the pre-heater, and flashed into the atmospheric tower where practically all of the solvent is flashed off, before being pumped into the stream stripper and on to finished storage.

Note from the diagram that all steam condensate from the strippers is collected in the bottom of the wax mix surge tank. As previously mentioned, the wax and solvent mix is preheated to about 120°F. before entering this surge drum. At this solution temperature any water crystals which are filtered out with the wax liquefy and settle to the bottom of the receiver so that all of the water is collected at this point simply by gravity.

The water from this point, containing about 10% solvent in solution, is then charged to a steam stripper where 85 to 90% concentrated solvent vapor passes overhead and returns to the system. The water condensate free of solvent passes out the bottom to drainage. A ball float type steam trap serves well as a level control if the trap has a vent return to the tower.

On the charge filtrate mix stream we usually provide a



FILTRATION SYSTEM
SOLVENT DEWAXING PROCESS

differential level recorder consisting of a differential flow transmitter with the remote air line connected to a 0 to 15-lb. pressure pen on one of the flow controllers inside on the panel, preferably the control on the primary recovery unit charge stream, so that the two records of charge rate and level are on one chart. The differential type level instrument is preferable here because of the wide range available. The differential leads will be trouble-free as the product here is wax-free. The flow from here on through the distillation unit is controlled by straight throttling level controls controlling the bottoms outlet rate. These are wide-range ball or differential type using the full allowed surge volume to smooth out any possible surges from changing charge rates. This is particularly important where charge to a stripper is being controlled by a level controller to avoid waste of stripping steam or priming of the stripper.

Note also a safety feature consisting of a mellon type float control mounted on the side of the vertical flow line from the small reboiler to the wax-free oil stripper controlling a butterfly valve in the vapor line from the reboiler. This, in many cases, avoids priming the stripper or the reboiler in case of a wide change of pressure on the stripper due to a hot condenser or some appreciable change in operating conditions. The static oil level simply rises in the vertical line till the float position is affected, which in turn closes the valve in the vapor line, increasing the reboiler pressure slightly to overcome the added resistance to entering the stripper. This condition continues until the operator notes that his temperatures are changing or that the stripper pressure has increased. If the tower pressure has lowered in the interim, no harm is done as the total stored oil in the line is insufficient to prime the stripper.

The rather unusual method of controlling the pressure on the high stage may be of interest. The vapor heat exchanger is of the vertical single-pass type with the high-pressure vapors outside the tubes and the filtrate charge inside. A back-pressure control valve is placed in the high-condensate-pressure outlet with the control point in either the tower or the incoming vapor line. A throttling type air-operated instrument is used and the method of installation is such that a decreasing pressure will close the condensate valve, causing the solvent condensate level to rise in the exchanger, blanketing the tubes, and thereby lowering the effective surface as a condenser until the required pressure is reached. No additional surface is added in the exchanger because of this method of control, and full advantage is taken of the surface installed to exchange sensible heat to the filtrate charge.

The control of the recovery system for the wax is a duplicate of the filtrate system, having one flow control on the charge and being controlled thereafter by level controls. No trouble is experienced with differential leads where the flowing mix is above the solution temperature. In this system no dehydrator is required and, this being single-stage evaporation, no pressure control is required.

In the larger plants or those where sufficient steam is not available, fired heaters are substituted for the steam pre-heaters shown before entry into the pressure tower. In this case two-stage evaporation is generally justified on both recovery systems. When fired heaters are used the flow control is placed on the stream entering the heater. The level control in the bottom of the atmospheric tower would then control the incoming charge to the system. Setting up constant conditions to the heater in this manner materially assists firing and control conditions at the heater.

When fired heaters are installed an additional safety feature is used, consisting of a snap-action or narrow-throttling-range pressure controller, so connected that when the pressure in the pressure stage rises above a pre-determined set point the fuel to the furnace is shut entirely off or down to a position to hold minimum safe fires; in either case

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Process Control in the Salt Industry

By H. W. DIAMOND and N. E. BERRY

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PROCESSING of salt involves a majority of the unit operations. Instruments play a prominent part in controlling these operations so as to safeguard the quality of the salt and maintain the desired efficiency. Temperature, pressure and flow recorders, controllers and recorder-controllers—all are needed. In the majority of installations, adapting these instruments to our processes involved no new principles. Therefore we have chosen four installations which should be of considerable interest by reason of their novelty, engineering detail or importance with regard to the efficient control of a unit operation.

Salt Drying

Improvements made by the instrumentation of a unit operation are exemplified by the results obtained from the installation of air flow controls on the salt driers. These driers, of which there are five, are of the rotary countercurrent flow type. The air for drying the salt is heated by steam coils and delivered to the driers by a fan. The amount of air needed to dry the salt is a function of the drier load—which is constantly changing. Variations in drier load are so great that the maximum is more than double the minimum and about 5/3 of the average drier load. These variations in drier load are due to many different factors, most of which it would be impracticable to regulate. Without air flow controls the quantity of air delivered to a drier is constant and must be sufficient to dry the salt during periods of maximum drier load The only way to improve the drier operation was to install controls which would make the amount of air going to the drier the minimum required to dry the salt at any given moment.

Possible ways of controlling the air flow to the drier were investigated. The temperature of the salt leaving the drier was recorded and a study of the charts showed that 200°F. was the lowest temperature at which the salt would leave the drier in a dry condition. Any excess air heated the salt considerably above this temperature, sometimes as much as 100 degrees. In order to obtain good drier economy it is therefore necessary to keep the salt temperature near 200°F. This can be done by regulating the flow of air to the drier in accordance with the temperature changes of the salt. Actually, this result is obtained with a salt temperature recorder-controller with built-in switches that cut in and out resistances in the armature circuit of a variable-speed d-c. motor driving the fan.

Other ways of controlling the air flow were suggested to us, for example, by means of louvres in the air duct to the drier. This method, however, involves the use of moving parts and did not seem to be either as simple or straightforward as using a variable-speed motor. It is also possible that the fan speed could be controlled by the temperature of the exit air from the drier. This method of control probably has some advantages over the method adopted, but we have not investigated it thoroughly.

The heat lost in the excess air used without controls was estimated to represent several thousand dollars a year. After we had confirmed this estimated loss with data obtained from drier tests, it was apparent that a reasonable return on the investment in instrumentation could be obtained. Air flow control instruments were purchased and installed on the five driers. The last drier was equipped just a year ago.

The operation of the controls and equipment is as follows: It was found that satisfactory economy could be obtained with four fan speeds over a 2.5:1 ratio. The temperature settings of the switches were set 4°F. apart so as to prevent hunting. The highest air rate (for the maximum drier load) is obtained at the lowest temperature setting which is 215°F. Actually this is 15°F. above the minimum salt temperature allowable: it provides a safety factor against occurrence of wet salt. When the salt temperature rises to 219°F. the fan speed drops back to the next lowest speed, and so on. Throughout a typical day the fan will run at the highest speed 10% of the time and at the lowest speed 20%.

All of the drier control instruments and equipment are standard items—some with minor changes but none "special" except perhaps the 2.5:1 ratio variable-speed motors which were built to order. It was necessary to deal with several different manufacturers in order to obtain all required equipment and instruments. It also was necessary to determine all engineering data required to specify to the manufacturers the fan h-p., the number of fan speeds, the fan speed change temperatures, etc.

The adaptation of instrument control to a unit operation of this kind involves close coöperation between the instrument manufacturer and the purchaser. In spite of the present high development of instrument technique, it is possible to obtain instruments that turn out to be unsatisfactory for the purpose intended. In this particular case, the first installation, while it provided us with considerable information on the operation of drier controls, soon had to be discarded. After this first installation, however, we knew definitely what kind of instruments and equipment we needed and were able to proceed with greater confidence with further developments. For instance, the first installation involved the use of a separate temperature-sensitive element for each fan speed. Great difficulty was encountered in distributing the salt uniformly over all the elements, some of which therefore responded faster than others. This caused erratic changes in the fan speed, which at times had no relation to the drier load. With the temperature recorder-controller this difficulty is eliminated since it has but one temperature-sensitive element.

The value of the steam savings effected by the controls in one year is about equal to their initial cost. The total cost of equipping five driers was $4,520 but this includes $800 for experimental equipment not used in the final installations, so that engineers with similar problems may figure on $3,720. The steam consumption in the air-heating coils was reduced by 31%, representing an annual saving of $3,700. The controls effected other savings which, though difficult to estimate in dollars, were important. These are: lower average temperature of salt leaving the drier, which aids in the subsequent handling and packaging of the salt; reduction in the amount of salt carried out of the drier by the exit air; and reduction in the amount of wet salt obtained. All in all, the annual savings exceed the initial cost.

Condensate Recovery

In contrast to the above instrument installation which required considerable development work, the installation of a conductivity meter for the recovery of the first effect vacuum pan condensate for boiler feed water required a minimum of such work. The steam used in this pan is obtained from flashing brine in the Alberger units. When good separation is obtained between the brine and vapor, the salt content of the steam is low. At times, however, separation is poor and the steam condensate is too high in salt content for use as boiler feed water. In order to determine the salt content of the condensate, an electrical conductivity recorder was obtained. Data were first obtained showing the relationship between salt content and conductivity so that the recorder could be properly ranged. This conductivity meter contains two disks whereby a bell signals an operator when the condensate is to be turned out or turned to the boilers. Extremely accurate results are being obtained from this instrument. In order to maintain this high accuracy the salt content of a daily sample is determined by analysis and com-

ced with the value shown by the record at the time the sample was taken. When a difference is found, it is only necessary to clean the conductivity cell to restore accuracy. This meter, like the drier controls, will pay for itself in about a year.

Brine Circulation

Our third example is that of circulation control in the Alberger process. It is not amiss to preface the discussion of the actual control, by a brief description of the Alberger process, since this method of salt manufacture is somewhat novel and is used nowhere else in the world. To facilitate this description, a simplified flow sheet of the process has been prepared (Fig. 1).

Fig. 1

All "evaporated" salt is of course produced by evaporation of water from a saturated brine. In the Alberger process the evaporation is carried out in what might be called a "closed" circulating system, since all of the brine entering the suction of the circulating pump, except about 7% which is evaporated during the cycle, passes through the entire system of heaters, gravellers, flashers and open pan and finds its way again to the suction of the pump—where feed brine is added to replace that lost by evaporation. Starting at this point, the first step in the process is that of heating. As the brine leaves the circulating pump and passes through the series of heaters, its temperature is raised to about 290° F.—considerably above the atmospheric boiling point, but evaporation is prevented by keeping the total pressure on the brine at least equal to the vapor pressure. From the heaters the brine is passed through a cylindrical vessel filled with stones, which is called the "graveller." Here, because of its elevated temperature, the brine deposits calcium sulphate. This is the method used for removing this major impurity in the brine.

The brine then passes on into the flashers, where most of the evaporation occurs: the pressure on the brine is released in steps in the three flashers in series and each drop in pressure brings about flash evaporation and an accompanying drop in temperature. In the third flasher the pressure is dropped to approximately atmospheric and it is here also that salt begins to crystallize. The mixture of brine and salt is then discharged from the third flasher, at the boiling point, through a pipe extending beneath the surface of the brine in an open pan. As the brine then passes through the open pan, surface evaporation and further crystallization occur and finally the brine overflows from the pan and passes again to the suction of the circulating pump.

Multiple-effect evaporation is obtained in the Alberger process by using the vapor from the first two flashers to heat the circulating brine in corresponding heaters and by using part of the vapor from the third flasher to heat the feed brine. Further economy is obtained by using the remainder of the flash vapor from all of the third flashers to operate a triple-effect vacuum pan plant.

It will now be obvious that the evaporation rate—and consequently the production rate—in an Alberger unit is a function of the brine circulation rate and of the temperature of the brine entering the first flasher. As formerly operated the variables measured and used to control the production of an Alberger unit were the flow of steam to the live-steam heater and the temperature of the brine leaving that heater. If the temperature of the brine entering the live-steam heater were constant, the measurement of the steam flow to this heater would be equivalent to a measurement of the circulation rate. But the temperature of the brine entering the live-steam heater depends upon the heat transfer in the preceding effect heaters, which in turn depends upon the size of the heaters, number of passes, condition of the tubes, and—in multi-pass heaters—the tightness of the heater heads. Needless to say, this temperature does vary considerably.

For this reason, among others, it was desired to measure the circulation rate directly, if possible. This measurement has been accomplished with no great difficulty by installing orifice meters. One difficulty is caused by the circulating brine being of such a concentration as to be saturated at about 210° F.: if nothing is done to prevent it this brine will diffuse into the meter lines, cool and deposit salt. This difficulty has been overcome by bleeding into both meter lines some cold feed brine at such a rate that no resistance head is produced while there is sufficient flow into the circulating pipe to prevent diffusion into the meter lines.

The circulation rate measured by these meters being about 1000 g.p.m., it was impracticable to make a "direct" calibration. Calibration was made by the mixture-velocity method: adding sodium thiosulphate at a measured rate to the circulating brine at one point and determining the concentration of thiosulphate by titration in samples of brine taken at a point farther on after complete mixing had taken place.

The flow recording instrument is a mechanical type, selected because of a novel feature which makes it possible to do without oil seals: the float-actuated mechanism of this meter is beneath the surface of the mercury and cannot therefore come in contact with brine in the meter body. The upper surface of the float does come in contact with brine but that is of no importance. Some reaction between the brine and the mercury has been observed resulting in the slow formation of mercurous chloride, but this can be entirely eliminated by introducing a thin layer of carbon tetrachloride on top of the mercury. Another feature of this meter is the elimination of any stuffing box on the pen-arm shaft, by the use of a radial magnetic coupling.

After the installation of a circulation meter was completed the difficulty of maintaining a uniform circulation rate by manual control became more strikingly obvious. This difficulty is largely due to an element of instability in the system which it might be well to explain briefly: For a given speed of rotation of the centrifugal circulating pump, the flow of brine produced by the pump will depend upon the discharge head. In this system the discharge head is largely dependent upon the pressure at the discharge of the graveller. As normally operated, the brine is beginning to flash at this point and the total pressure is equal to the vapor pressure of the brine being discharged. It will then be seen that in case something happens to slightly reduce the speed of the circulating pump, since no change will have been made in the control of steam to the live-steam heater, the brine temperature will rise as will the vapor pressure and an increase in discharge head will further reduce the circulation rate. The decrease in circulation rate will further increase the brine temperature; further reduction in circulation rate will result, and so on, greatly accentuating changes in the circulation rate.

This difficulty has now been met by the installation of air-operated type automatic flow controllers. In these installations the flow-responsive element which drives the pen of the recorder actuates also a pilot air valve, thereby operating a diaphragm valve in the steam line to the turbine-driven circulating pump. (See Fig. 2.) The controller selected is not of the "automatic-reset" type and if used to

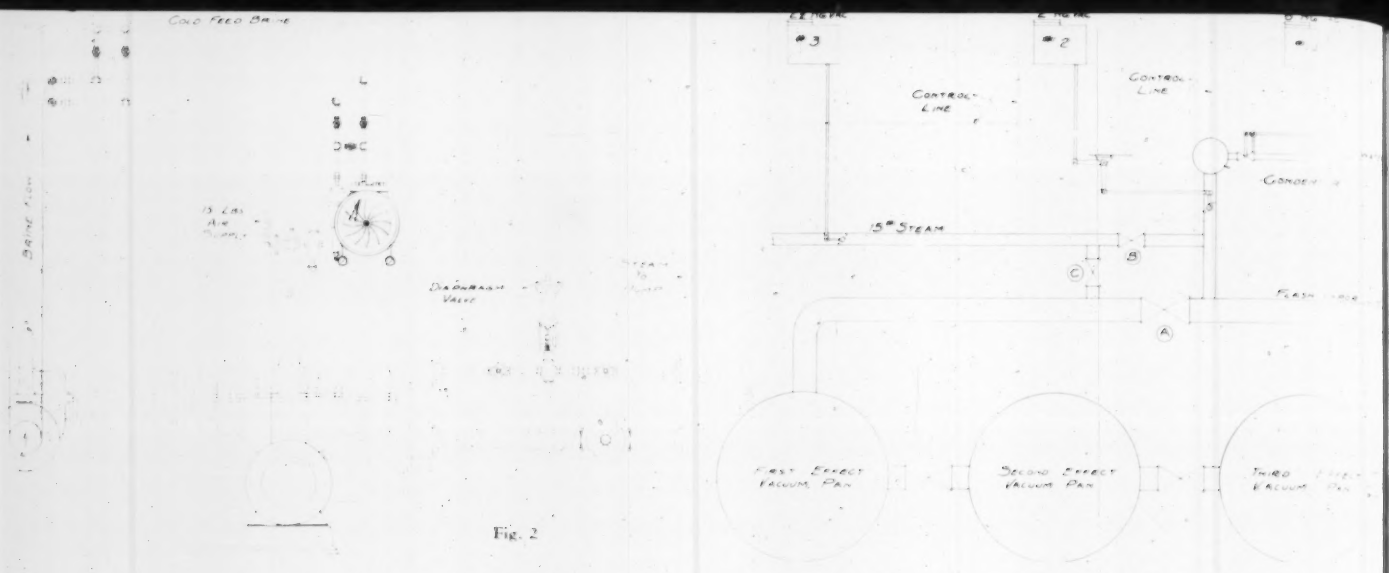

Fig. 2

control the entire supply of steam to the turbine, would not give sufficiently definite control for variable loads without being adjusted for extreme sensitivity, which would produce excessive hunting. In this installation only about one-third or less of the steam supply is controlled. Even with this method some hunting was observed but it has been satisfactorily minimized by cutting down the speed of reaction of the flow meter.

The results of the installation of these flow meters and controllers in the Alberger process are a much more uniform production rate and more uniform operation in general than was previously possible. The complete installation on five Alberger units was made at a cost of about $4000 and there is no doubt in the minds of the most skeptical that the resultant annual operating savings exceed this amount.

Vacuum Balance

The next and last example of process control which we wish to present is involved in maintaining the required vacuum balance between the Alberger systems and the vacuum-pan plant when the latter is using flash vapor from the Alberger third effect flashers. It is essential that a vacuum of about one-half inch of mercury be maintained on the vapor lines of these flashers (see Fig. 3) and since the supply of flash vapor is somewhat variable as is also the consumption at the vacuum-pan plant, it is obvious that some automatic control is almost a necessity.

For normal operation, the pressure drop in the vapor line between the Alberger third flashers and the vacuum pan plant is about 1.5" Hg. Therefore, the flash vapor line in the vacuum pan plant is maintained at between 2" and 2.5". This vacuum can only be maintained in the steam belt of the first effect vacuum pan with a definite supply of steam to that pan; and it is therefore necessary to provide some means of taking care of the cases when the supply of flash vapor does not exactly agree with the consumption of the first effect pan.

To take care of the case when the supply of flash vapor is in excess of the vacuum pan consumption, an auxiliary condenser is provided. The vacuum in this condenser is maintained at roughly 6" Hg by means of automatic controller No. 1 which operates the control valve in the water line. Then a butterfly valve in the line between the flash vapor main and the auxiliary condenser, automatically operated by controller No. 2, opens when the vacuum in the flash main becomes less than 2" Hg and maintains the vacuum at this point.

In the case when there is a deficiency of flash vapor, the vacuum in the flash main rises, the butterfly valve to the auxiliary condenser completely closes and when the vacuum increases to 2.5" Hg some auxiliary 15-lb. steam is introduced to make up the deficiency. This is automatically accomplished by controller No. 3 which operates the butterfly valve in the 15-lb. steam line.

When it is desired to operate the vacuum pan plant at a lower production rate, valve A in the flash main is throttled until the desired vacuum is attained on the first effect pan. At the same time valve C in the 15-lb. steam line is closed while valve B is opened, thus making it necessary for all steam to pass through the throttled valve A. The vacuum in the flash main ahead of valve A is still automatically maintained at between 2" and 2.5" Hg. If it is desired to operate the vacuum pan plant on 15-lb. steam when the Alberger systems are not operating, valves A and B are closed and valve C is opened. The vacuum can then still be automatically controlled by controller No. 3 by merely shifting the control point beyond valve A in the flash main.

Controllers of the oil-operated "automatic-reset" type have been used in this installation. They will maintain a vacuum within $\frac{1}{4}$" Hg over the entire load range and no difficulty with hunting has been experienced. Occasionally some wide and rapid variations have had to be met and invariably these controllers have been found capable of maintaining the desired vacuum.

In conclusion it might be observed that in the salt industry we are engaged in the production of one of the cheapest commodities in the world and for this reason it has been more or less traditionally assumed that "fancy" controls cannot be made to pay for themselves. Yet, in each of the four instances of process control which we have presented, the control installation has, or will have, paid for itself within one year.

Instrumentation of Solvent Dewaxing Process

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these conditions are held until the instrument or valve is manually reset to the original open position. This instrument almost entirely eliminates the possibility of solvent loss out of the relief valves.

The water stripping column charge is flow controlled; the only other instrument being a vapor-tension type temperature control equipped with automatic-reset mechanism. The bulb is placed about one-third down the column; and the temperature at this point is maintained by controlling the quantity of stripping steam to the tower.

The wide difference in the boiling points of the solvent and ordinary lubricating oils make tower top control a simple problem for good separation. Only in the case of low flash point oils is it necessary to automatically control any but the top of the pressure flash tower. Simple vapor tension wide-throttling-range temperature controls are usually satisfactory for controlling these temperatures. The control valves are all in the solvent reflux lines from the primary solvent system.

The temperatures at all these points are indicated on a potentiometer type indicator, none displaying variations of sufficient importance to justify recording, except perhaps the fired heater outlet on a large unit.

Installation

Practically all of these instruments are centrally located on one panel board in the pump room, the exceptions usually being temperature controls with exceptionally long tube lengths and differential type level manometers for recording or controlling. In such cases electric or pneumatic telemetering systems are often used.

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RECENT DEVELOPMENTS and OPERATION of INSTRUMENTS for Controlling Cracking Equipment in response to Yield-per-pass and *in situ* Density

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CONTROL of the factors influencing treatment under conditions where the velocity of a fluid can be varied independently of frictional resistance is much more difficult than in the earlier batch methods. Control equipment to regulate and maintain rates of charge, temperatures, and pressures had been developed chiefly for the field of steam generation, and when this instrumentation was applied to control the treatment of petroleum hydrocarbons difficulties were encountered. The complexity of petroleum as compared with water and steam led necessarily to the development of a variety of special instruments. After an extensive period of trial and error, one of the results of this development was the production of instruments suitable for controlling the fuel supply in accordance with values of temperature at selected points of the system.

In the cracking of petroleum products it is recognized today that temperature is only one of the variables affecting the degree of conversion and the quantity of heat required to maintain a given conversion rate. The cracking reaction may involve vaporization and both endothermic and exothermic chemical changes, and none of these effects can be followed from temperature indications alone. The development of a method for the continuous determinations of the density *in situ* of a flowing fluid at any point in its path has rendered density values available as a basis for controlling the time of treatment and the heating of the fluid. Instruments have been constructed for regulating control variables in accordance with density of the fluid at any selected points in the path of treatment. The principles involved in the development of this instrumentation were the subject of a paper presented recently before the American Petroleum Institute,* and it is the purpose of the present paper to give a detailed account of the installation and operation of this equipment, together with some of the results observed.

Principles of Measurement of Density, Time, and Yield Per Pass

Density determinations in flow systems are based on the use of the following hydraulic equation (or some form equivalent to it):

$$h_1 d_1 (cfd^2)_1^2 = h_2 d_2 (cfd^2)_2^2, \qquad (a)$$

where d_1, d_2 are the values of the density of the fluid at any two points of its path; h_1, h_2 are differential heads developed across orifices placed at those points; and $(cfd^2)_1$, $(cfd^2)_2$ are coefficients which are characteristic of the orifices (c, coefficient of discharge; f, approach factor; d, diameter). If d_1 is known, a knowledge of the differential heads and the orifice coefficients enables d_2 to be found. In this way density values can be followed from a point where they can be determined readily by familiar means, to any other point of the path of flow.

The density at (say) the outlet of the conversion section of a cracking coil varies considerably under different operating conditions. On account of the large variations in differential head which would then be encountered, the installation of a fixed orifice at such a point is impracticable. For this reason the first step in the practical realization of a flexible density apparatus consists in the construction of an adjustable orifice (Fig. 1), in which the area ratio can be varied as desired. Moreover, an important advantage of an adjustable orifice is that it permits a check to be made on the consistency of density values obtained at different segment settings. In those cases where it is necessary to cool the orifice in order to keep the apparatus in operating condition, provision is made for a supply of cooling oil to be passed through the body, stem, and plate of the orifice assembly.

If it be required to determine the time of detention of a fluid in a certain section of its path, the density of the fluid at the inlet and outlet of the section can be found in the manner described above, and the mean density (d_m) then used to calculate the time (t) in accordance with the relation

$$t = V d_m / W, \qquad (b)$$

where V is the volume of the section under consideration, and W the weight-rate of flow.

From a knowledge of the time of detention and the mean temperature in a section of the fluid path it is possible to calibrate that section to determine the degree of conversion taking place in it. This calibration consists merely in the empirical correlation of yield with time, temperature, and those characteristics of the charging stock which most simply express its behaviour under cracking conditions. On the basis of certain simple assumptions an empirical equation for the yield per pass (P) can be established, and it is found to have the following form:

$$P = \frac{A\,G}{1000} C\, t\, 10^{(T - F_0)\, t}, \qquad (c)$$

where t is the time, T the temperature, A the aniline number, and G the gravity of the stock. The adjustable con-

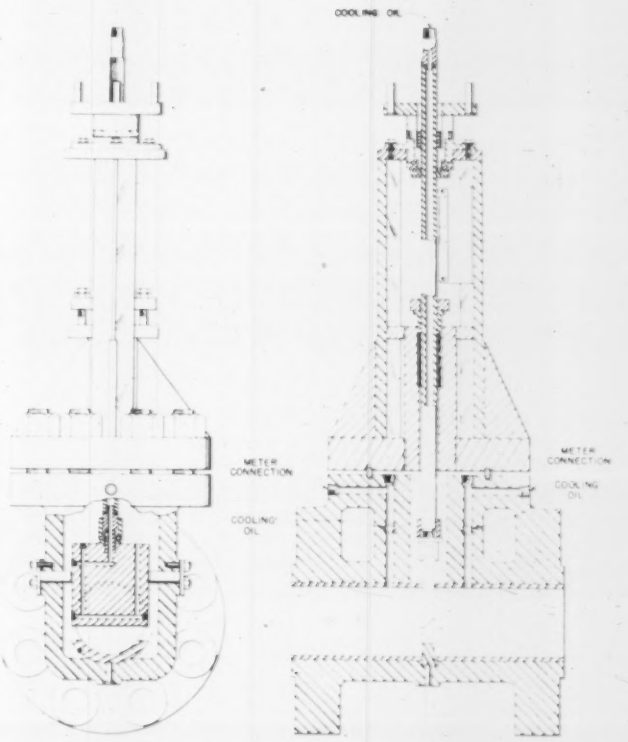
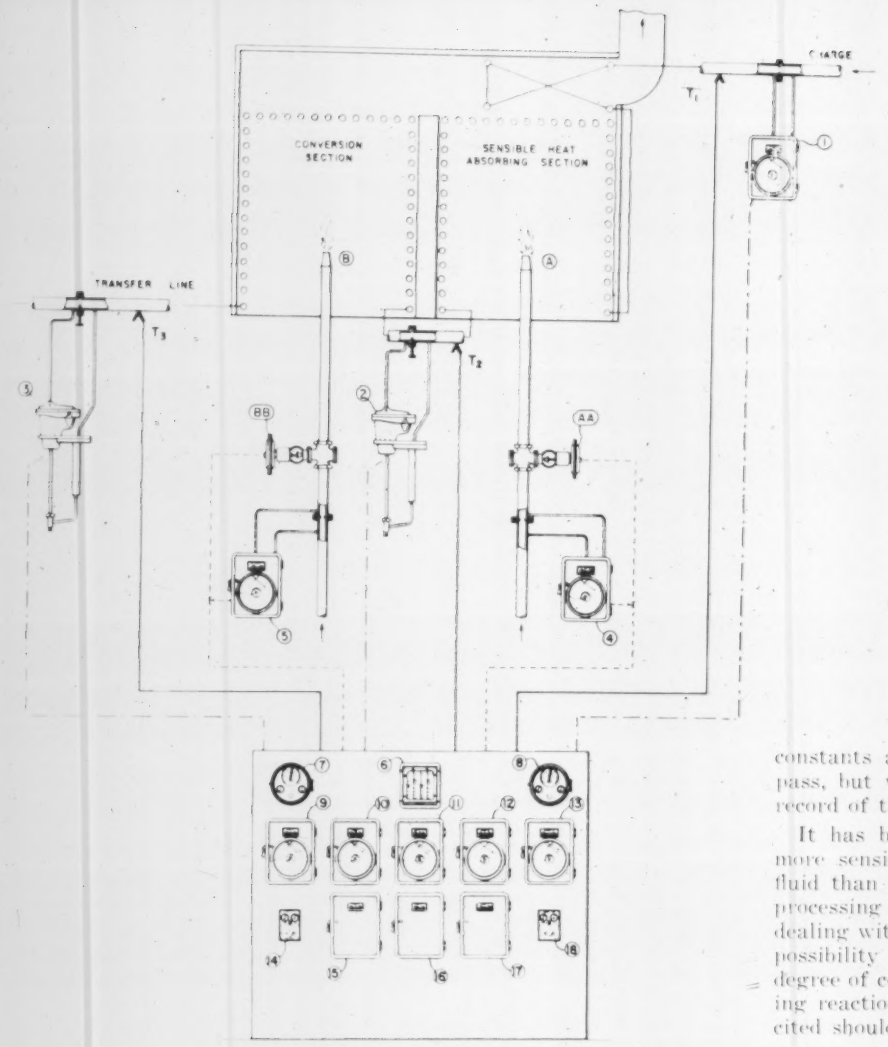


Fig. 1. Diagram of Adjustable Orifice.

*"The Determination of Yield Per Pass, Time of Treatment, and *in situ* Density, and Instrumentality for their Controls in Commercial Cracking Units." By Robert L. Rude, Raymond Junkins & Colin Barnes. Annual Meeting, A.P.I., Chicago, November 1938.



— LEGEND —

① CHARGE METER – RECORDS RATE OF CHARGE TRANSMITS h_1 & $\sqrt{h_1}$

② INLET METER – TRANSMITS h_2

③ OUTLET METER – TRANSMITS h_3

④ FUEL METER – BURNERS A

⑤ FUEL METER – BURNERS B

⑥ INDICATES { FUEL RATE TO BURNERS A; FUEL RATE TO BURNERS B; RATE OF CHARGE

⑦ CONTROLS FROM T_2 , ⑧ CONTROLS FROM T_3

⑨ RECORDS T_1 & T_2 ⑩ RECORDS d_2 & d_3

⑪ RECORDS md & TIME ⑫ RECORDS YIELD PER PASS

⑬ RECORDS T_3 & $\frac{T_2 + T_3}{2}$

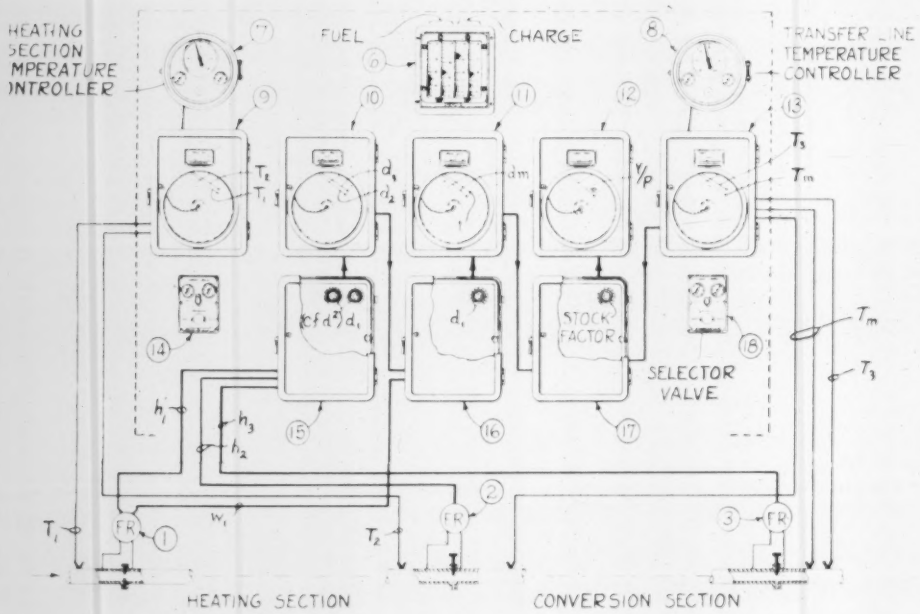
⑭ SELECTIVE CONTROL OF BURNERS B – MANUALLY – OR AUTOMATICALLY FROM md OR T_3 OR Y/P

⑮⑯⑰ MECHANISMS WITH 10, 11, 12, RESPECTIVELY

⑱ SELECTIVE CONTROL OF BURNERS A – MANUALLY – OR AUTOMATICALLY FROM T_2 OR FROM d_2

Fig. 2. Diagram of Furnace with Associated Controls and Instruments.

Fig. 3. Diagram of Panel Board Showing Interrelation of Instruments.



stants C, T, f in this expression will naturally vary from one installation to another, and must be adjusted to suit individual cases. Thus the values of the constants required to give the percentage yield per pass over a chosen operating range of temperatures (° F.), times (minutes), and stocks were found to be:

$$C = 0.92, \qquad T = 850, \qquad f = 73.$$

It should be noted, however, that the actual values of these constants are not necessary for a control from yield per pass, but will be required only if it be desired to have a record of the actual yield.

It has been found that density values often provide a more sensitive indication of the degree of heating of the fluid than does temperature. This is to be expected in the processing of petroleum hydrocarbons where one may be dealing with progressive physical and chemical change. The possibility of independent adjustment of heat absorbed and degree of conversion is a characteristic feature of the cracking reaction. For further details the publication previously cited should be consulted.

Instruments for Controlling and Recording Cracking Variables

A diagram of the furnace and the general scheme of instruments is shown in Fig. 2. The differential heads at the orifices and the temperatures at the thermocouples installed in the path of flow are transmitted to the control panel (Fig. 3), where the variables are recorded and used, separately or in chosen combinations, to control the fuel supply to the different sections of the furnace.

The temperature T_1 of the furnace charge and that T_2 of the oil leaving the heating section of the furnace are recorded by instrument 9 (see Figs. 2, 3), and T_2 is transmitted to 7 from which, if desired, the fuel supply to the heating section may be controlled. The temperature T_3 at the outlet of the conversion section and the mean temperature T_m across the conversion section are recorded in 13, from which T_3 is further transmitted to 8, which, when desired, may be used to control the fuel supply to the conversion section.

The values of the differential heads developed at the fixed orifice at the furnace inlet (h_1) and at the adjustable orifices at the inlet (h_2) and outlet (h_3) of the conversion section, are transmitted electrically to 15, where they take the form of resistances constituting arms of Wheatstone bridge circuits. These circuits also include resistances which can be manually adjusted in conformity with the values of cfd^2 at the adjustable orifices, and a resistance adjustable for changes in the density (d_1) of the charge at the inlet orifice. The self-balancing bridge circuits automatically compute density values in accordance with equation (a). The

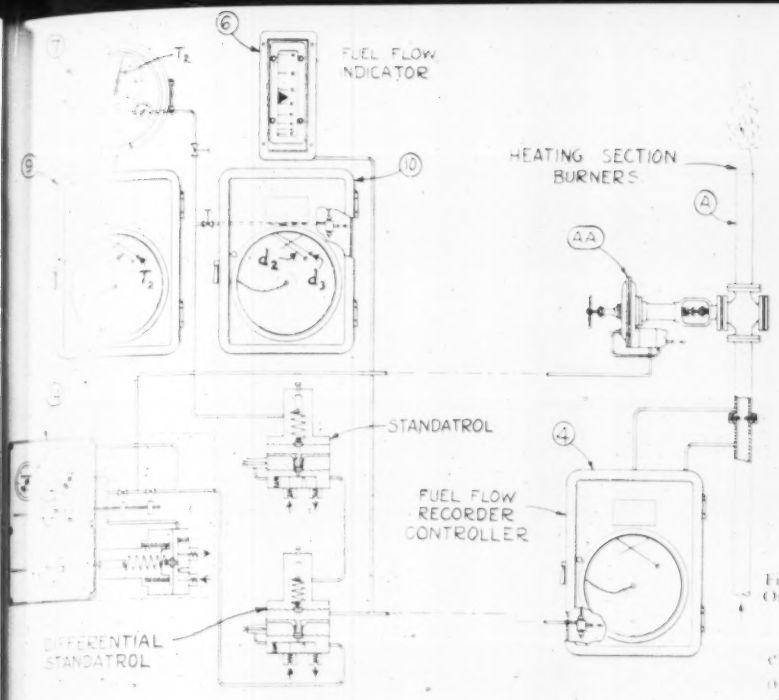


Fig. 4. Diagram of typical Manual and Automatic Control System.

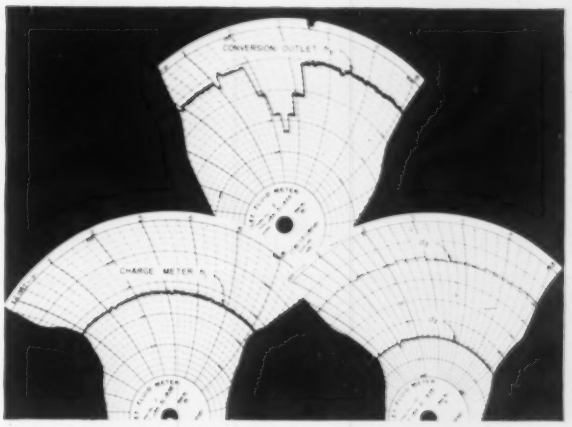


Fig. 5. Charts Illustrating Effect of Changing Setting of Adjustable Orifice.

density (d_2) at the inlet to the conversion section and (d_3) at the outlet are recorded in 10 and transmitted to 16, where their mean value is computed. By a further bridge circuit the mean density is combined with the volume of the conversion section and the weight-rate of input to give the time in accordance with equation (b); the weight-rate of input itself is derived by transmission of differential head from the charge meter, the density of the charge being incorporated by manual setting. The mean density (d_m) and time (t) computed by the circuits in 16 are transmitted to 11 where their values are recorded. A bridge circuit in 17 receives the time-value from 11 and the mean temperature of treatment from 13. These values (as resistances) are there combined by a circuit which includes a manually adjustable resistance for variations in stock character, to compute the yield per pass from equation (c), the yield (Y/P) being then recorded in 12.

An air pilot-valve mechanism in 10 permits the density at the inlet to the conversion section to be utilized for controlling the fuel supply to the heating section of the furnace. A similar mechanism in 11 enables the fuel supply to the conversion section to be controlled, if desired, from mean density. In the same way it is possible to control the conversion section from the indications of yield per pass in 12.

Thus the instrumentation is such that it is possible to control the fuel supply to the heating section either from temperature, or from the density at the outlet of that section; and that it is possible to control the fuel supply to the conversion section either from temperature, or from mean density, or from yield per pass.

A flexible control system for cracking equipment must be so designed that it is possible to pass quickly and safely from automatic to manual control. This important feature of the instrumentation here described is performed by selector mechanisms, one of which is shown diagramatically in Fig. 4, its function being to pass from automatic to manual control (and *vice versa*) of the fuel supply to the heating section. With the switch in the "hand" position it will be seen that the control pressure, as regulated by the lower knob, is transmitted directly to the fuel supply valve AA, the automatic control circuit being cut off. With the switch in the "automatic" position the pressures transmitted from the fuel flow controller 4 and to the fuel supply valve AA are in equilibrium through a relay mechanism, the "differential Standatrol". If the fuel supply is being controlled from (say) d_2, the pressure transmitted from the pilot-valve mechanism in 10 is relayed through the "standatrol" to the upper chamber of the differential standatrol, where it acts to modify the pressure on the supply valve AA by varying the controlling air pressure in the lower chamber. These relay mechanisms are essential for stable operation and positive action of air-actuated controls of this kind. To prevent discontinuities in operation when passing from automatic to hand control (and *vice versa*) the "reset" positions of the switch are provided to enable equalization of control pressures before completing the transition. Similar selector mechanism is used in connection with the control of the fuel supply to the conversion section. Fuel flow indicators 6 are provided in the control house, where they reproduce the indications of the recorders 4, 5. It takes less than a minute to switch from automatic to manual control using this mechanism, the loading pressure on the fuel control valve AA being adjusted in the reset position so that the fuel indicator 6 on the panel board gives the normal reading for automatic control.

One example may be given of the ways in which the equipment may be tested periodically for accuracy. The charts in Fig. 5 show a record of differential head at the inlet charge meter, of differential head at the outlet of the conversion section, and of density at the inlet and outlet of the conversion section. These charts were taken over the same period of time, and show the effect of changing the segment setting at the outlet of the conversion section and making the corresponding manual adjustments of the resistance in instrument 15.

The following table gives a comparison of the values of outlet density d_3 as recorded on the chart with values calculated from the head h_3 at the outlet for the different segment settings expressed in inches of stem travel at the orifice. The 6% difference between the two sets of density values is an indication that a slight adjustment of the resistance values in the instrument is necessary.

Value of h_3 (Inches of Water)	Segment Setting	d_3 (lbs/ft.^{3}) from h_3	d_3 from chart
194	2.0	10.5	9.7
147	1.8	10.2	9.6
110	1.6	10.0	9.3
83	1.4	9.9	9.3

It is not enough that an automatic control system be able to control a process when operating conditions are normal. When some part of the installation fails to perform its usual function, a major disturbance may result. Even when this disturbance originates in a part of the installation which is not commanded by the control instruments, the latter must still be expected to compensate (within reasonable limits) for the effects of the disturbance. The confidence placed in the ability of the control system to keep such effects within safe limits must be such as to leave the operators free to correct the conditions causing the original disturbance.

The modern combination unit, designed for increased thermal efficiency, is possible only as a result of the development of automatic controls. These controls must often be made deliberately insensitive in order to keep the system in stable operation and to avoid hunting cycles. When an instrument is made insensitive for this purpose the result (practically equivalent in many cases to by-passing its controlling function) is to introduce a time-lag of such a magnitude that the instrument is incapable of participating

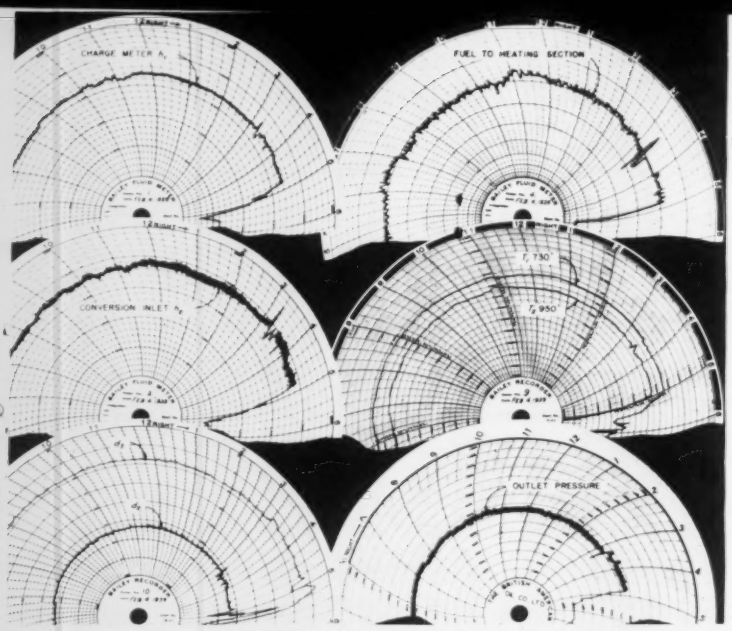


Fig. 6. Charts Illustrating Heating Section Controlled from Density (d_2).

effectively in the efforts of the control system to cope with the results of a major disturbance.

The behaviour of the control system described in this paper demonstrates the fact that, without having to decrease the sensitivity of control instruments, stability and flexibility of operation can still be maintained as a result of the interrelation of the most essential variables entering into control of the process. The cracking reaction (for a given stock) depends on time and temperature, the values of which are dependent primarily upon rate of charge, heat-release, and pressure. The variables (density, temperature) for the control of the heating of the charge to cracking temperature, and those (time, temperature, and their correlation with yield per pass) for the control of the cracking reaction, are interrelated to give stable operation without loss of sensitivity. A study of the charts which follow shows that this interrelation results also in a control system sufficiently flexible to cope with major disturbances caused by failure of parts of the equipment to perform their normal functions.

The charts in Figs. 6 and 7 have been selected to cover a period during which certain abnormal conditions prevailed. During this period the heating section was controlled from the density at the outlet of that section, and the conversion section was controlled from yield per pass. Over a six-hour period (5-11 p.m.) the API gravity of the furnace charge increased from 21 to 26, and a number of minor changes were made in the adjustment of the control setting of the density (d_2) controller regulating the fuel supply to the heating section. These changes in the control setting were made when it was observed that the temperature (T_2) at the outlet of the heating section had a tendency to drop below 950°F., a value which had been rather arbitrarily selected as representing a reasonable distribution of duty between the two sections of the furnace. The outlet of the heating section could, of course, have been controlled (by instrument 7) to a constant temperature of 950°F., and density (d_2) allowed to fluctuate from changes in the inlet charge density. However, it was desired here to illustrate the effect on T_2 of variations in charge characteristics when controlling from d_2. As a result of the changes in the control setting the density at the inlet of the conversion section dropped from 28.8 to 26.5 lb. ft.$^{-3}$. The fuel fired in the heating section is shown on the chart from the fuel meter 4.

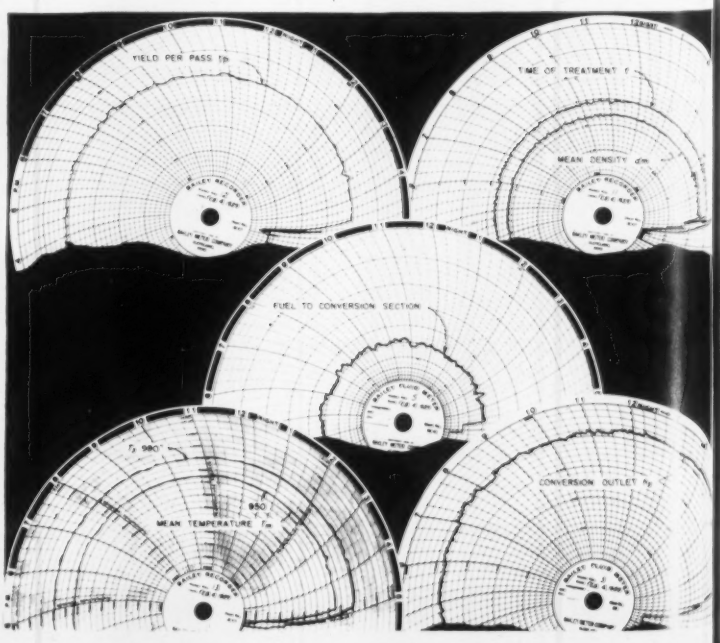
Over the same interval the yield per pass control was set at approximately 20%, and was not changed. No changes were made in the stock factor resistance, so that the control of the conversion section consisted essentially of an automatic time-reset for the temperature control. The time-temperature part of the yield-per-pass equation (c) thus regulated the fuel supply to the conversion section. The fuel supply itself is recorded on the chart from the fuel meter 5.

The charts shown in Fig. 6 exhibit also the behavior of the control system when the operating conditions have become unbalanced. It is an emergency like this one which tests the efficiency and reliability of an automatic control system. Trouble from the packing in the main back-pressure control valve occurred at about 3.15 a.m., and while attempting to correct it abrupt changes in outlet pressure of about 200 lb./in.^{2} were made. (Continuation of this trouble with the back-pressure valve finally resulted in the unit being shut down at about 5 a.m.) These changes in pressure were sufficient to cause variations of 5% in the rate of furnace charge. It will be seen from the charts in Fig. 6 that the decreased pressure lowered the density d_2 by about 1.5 lb./ft.^{3}. The heating section was controlled from d_2, and a decreased fuel supply was the result. With the sudden increase of pressure of about 200 lb./in.^{2} the density d_2 increased by about 2 lb.ft.$^{-3}$, and the fuel supply was correspondingly increased. It will be noted that the changes in weight-rate of input largely compensated for the changes in head h_2, and that there was no perceptible time-lag between changes in pressure and corresponding changes in density d_2. On the other hand, T_2 rose and fell much more slowly than density, and fluctuated at most by 4°F. about the normal value. (While the system was correcting itself from the effects of this disturbance, the fireman, accustomed to the use of conventional control equipment, unfortunately switched to hand control of the heating section, and automatic control was not resumed until some 30 minutes later.) On a number of occasions a careful comparison of minor variations in temperature T_2 and density d_2 was made, and it was observed that changes in density were not only more sharply defined than the associated changes in temperature, but preceded these changes by from one to two minutes. By constrasting the fuel chart (of meter 4) in Fig. 6 when controlling from d_2 with the corresponding chart in Fig. 8 when controlling from T_2, it will be seen that the two types of control are characteristically different and provide a further indication of the greater sensitivity of the density control.

The charts shown in Fig. 7 are for the same period of operation as those in Fig. 6, and apply to the control of the conversion section from yield per pass. It will be noted that the abrupt changes in differential head h_3 were also largely compensated by the changed rates of charge, so that the density at the outlet of the conversion section was not materially affected. However, time and mean density were slightly changed from the change in d_2, and the combined influence of time and temperature caused a variation of about 1% in the yield per pass. This resulted in a minor change in the fuel fired in the conversion section (recorded by meter 5), and the outlet temperature did not vary by more than 5°F.

To compare the above method of control with the ordinary control from temperatures at the outlets of the heating and

Fig. 7. Charts Illustrating Conversion Section Controlled from Yield-per-pass.



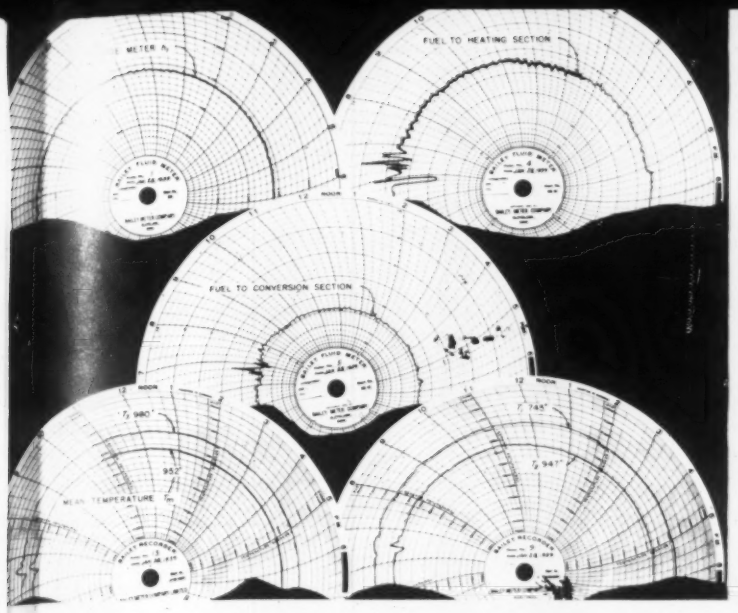


Fig. 8. Charts Illustrating Heating and Conversion Sections Controlled from Temperature.

conversion sections, under conditions where a considerable disturbance is occurring, attention is directed to the charts in Fig. 8. Shortly after 6 a.m. trouble with the charge pump (caused by the vacuum from the barometric condenser) resulted in the rate of charge falling rather suddenly by about 3%. The temperature at the inlet of the conversion section dropped gradually by about 10°, then rose rather abruptly by about 20°, and then slowly came back to the control temperature setting. The temperature at the outlet of the conversion section dropped by about 10°, then rose abruptly by 25°, and an hour elapsed before the control recovered completely from the effects of the rather slight change in rate of charge.

The fuel charts show the operation of the controls on the heat-release in their efforts to recover from the effects of the change in rate of charge. With normal operating conditions the temperature lines are almost perfect circles, but this is not due to insensitivity since it will be seen from the fuel charts that the temperature controllers are sufficiently responsive to minor variations in operating conditions. The tendency for temperature controls on cracking coils to overshoot is generally recognized, and to avoid setting up a hunting cycle it is necessary to adjust these controls so that excessive changes in heat-release will not result from minor temperature changes. Since temperature is only one of the variables entering into the heating and cracking operation, a precise control of the temperature is not possible unless *both rate-of-charge and pressure* are regulated to within fairly narrow limits.

This brief analysis of the operation of the control system, as exemplified by the charts in Figs. 6, 7, 8, is sufficient to exhibit the stability and flexibility of a method of control based on the utilization of the fundamental variables of the process under consideration. As contrasted with a system of control from a single variable, where it is impossible to cope with a major disturbance in the system, the present control system appears capable of limiting the effects of such a disturbance to a marked extent.

As an illustration of additional safety factors introduced by using a control from density, suppose that an emergency caused by the stopping of the charge pump arises. If the heating section is controlled from density d_2 at any selected setting, the rate of firing will be diminished regardless of temperature, since vaporization tends to decrease the density when the weight-rate of input decreases. As regards the control of the conversion section from yield per pass, the decreased weight-rate of charge increases the time of treatment (in spite of the fact that the outlet head meter may go to the maximum reading of differential head). This increase in time reduces the temperature, thus illustrating the fact that the reduction in fuel fired is not limited to the amount necessary to hold the temperature constant, but is further reduced by the effect of time on temperature. The failure of the back-pressure control valve or the rupture of a tube will also result in decreased density values which, with control from density or yield per pass, will result in reduced rates of firing. Thus controls from density *in situ* provide definite advantages from the point of view of safety.

Remarks on Installation

One of the most vital elements in the efficient and reliable operation of air-operated controls is an adequate supply of clean air, free from lubricating oil, moisture, and any foreign particles. Without taking precautions to insure the cleanliness of the air supply it is not uncommon to find pilot-valve mechanisms fouled with foreign matter and condensate. Climatic conditions prevailing at the site of the refinery must dictate many of the practices employed to insure continuity of operation and to reduce maintenance of equipment to a minimum. Under those severe conditions arising during sub-zero weather it is not unusual to encounter interruptions due to frozen water or fuel lines, and to failures in the electrical service. During interruptions of this character it is frequently necessary to pass from automatic to manual control, and operation then becomes increasingly dependent on the available supply of instrument air. An effective means of cleaning and drying air for this purpose consists in passing the air discharged from the compressor through a water-cooler and into a separating tank. Cooling to about 40° F. at pressures from 100 to 150 lbs. in.$^{-2}$ removes a considerable amount of the moisture contained in the air, and the greater part of the lubricating oil is emulsified with the condensed water. The air is then passed through a filter packed with successive layers of rockwool, fuller's-earth, and hair-felt. The pressure is then reduced to that of the instrument supply header (about 40 lbs. in.$^{-2}$), and the air is distributed through brass pipes to eliminate pipe scale.

To minimize operating difficulties and hazards due to the use of long static lines, it has been found advisable to install many of the flow-meter transmitters at locations near to the primary metering elements to which they are attached. A few views have been chosen to illustrate the way in which some of the meters exposed to atmospheric conditions have been installed, and the steps taken to insure continuous and reliable operation regardless of weather conditions.

Fig. 9 is a view of the adjustable orifice at the outlet of the conversion section and of the housing in which are installed the meters used for transmitting the differential heads h_2 and h_3 to the panel board. Fig. 10 is a view of the interior of this meter housing, and shows the seal-pots installed above the manometers, and a steam coil for maintaining a temperature necessary for the proper functioning of the meters. In this installation it will be seen that means have been provided for the independent equalization of the mercury in the manometers, of the sealing fluid in the pots, and of the transmitting fluid above the sealing fluid. Fig. 11 is a view of the fuel meter housing and the installation of the fuel control valves. Fig. 12 shows the interior of the fuel meter housing, showing the arrangement of the seal-pots

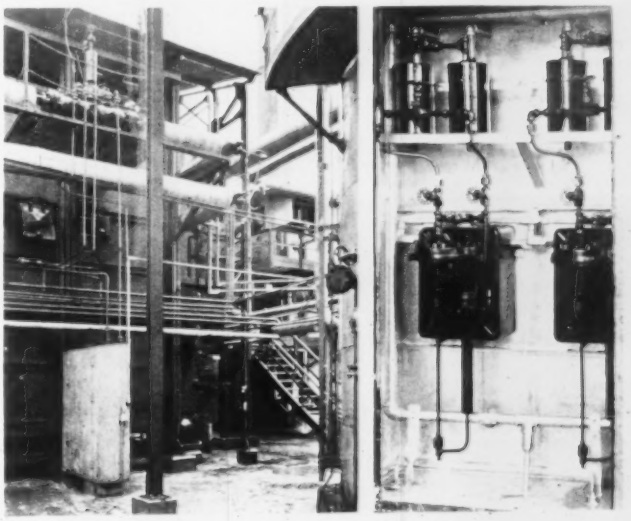


Fig. 9. View of Adjustable Orifice at Conversion Section Outlet, and Associated Piping and Meter Housing.

Fig. 10. Interior View of Meter Housing in Fig. 9.

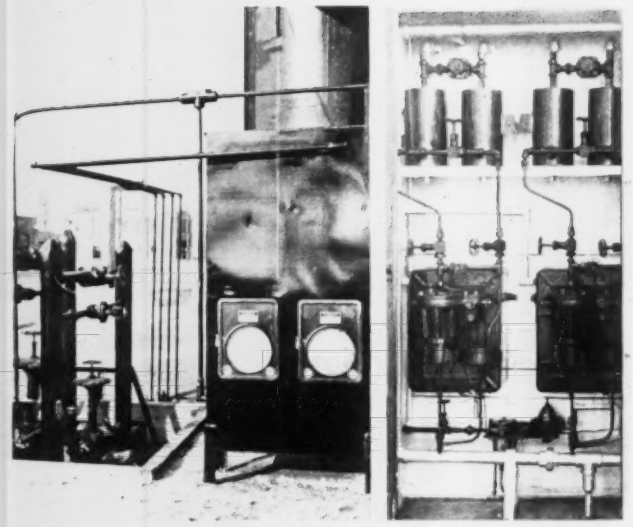


Fig. 11. View of Installation of Fuel Gas Meters and Control Valves.
Fig. 12. Interior View of Fuel Gas Meter Housing.

and equalizing valves. By minimizing the corrosive action of hydrogen sulphide in the fuel gas, it has been found that the maintenance of the fuel meters can be decreased materially. This is accomplished by sealing the gas off from the manometers by means of seal-pots containing a solution of ethylene glycol (30%), water (45%), and glycerine (25%), a composition selected to prevent the viscosity becoming too great at low temperatures. The seal-pots also provide for the accumulation of condensate which tends to settle in static lines in gas systems exposed to sub-zero temperatures. The equalizing valves make it possible to correct for this accumulation without dismantling the equipment.

The question of explosion hazard arising from electrical contacts used in transmitting some of the control factors has been given careful consideration. Fig. 13 is an interior view of the charge meter transmitting the differential head h_1 to the panel board. This meter is located near to the furnace and to the charge meter orifice assembly, and in this illustration a torque amplifier will be recognized. It effects the transmission of the differential head h_1 to instrument 15 on the panel in the control house. The only explosion hazard conceivably arising in connection with the instruments on the main control panel is that from galvanometer circuits using Warren motors to drive the recording mechanism.

In a blank-faced case located in the lower right-hand corner of the view of the control board (but not drawn in Fig. 3) are mercury tumbler switches serving the individual instruments on the panel. These provide safe means for cutting off any one of the instruments, and are under the observation of the instrument man while he is working on an instrument. This obviates the possibility of an instrument being switched on while it is undergoing repair or examination, a hazard which is always present when the switches are all located in a box outside the control room.

Another operating difficulty arising from severe climatic conditions is the crystallization and deposition of naphthalene in the lines carrying the supply of cooling oil to the orifice assemblies. The stock used as cooling oil was a bubble tower side-cut (fluid at —50° F.), but it nevertheless contained enough naphthalene to cause the trouble, and to prevent the lines becoming plugged it was found necessary to insulate them.

CONCLUSIONS

An examination of the literature reveals the lack of precise information regarding yields in cracking. This situation is inevitable as long as cracking is considered from a point of view which ignores the time-element involved. No data of permanent value can be accumulated unless practical procedure is sufficiently standardized to enable the results obtained by different observers to be compared on a common basis. The study and control of cracking must utilize the values of all the essential variables (time, temperature, and stock factors) entering into the reaction.

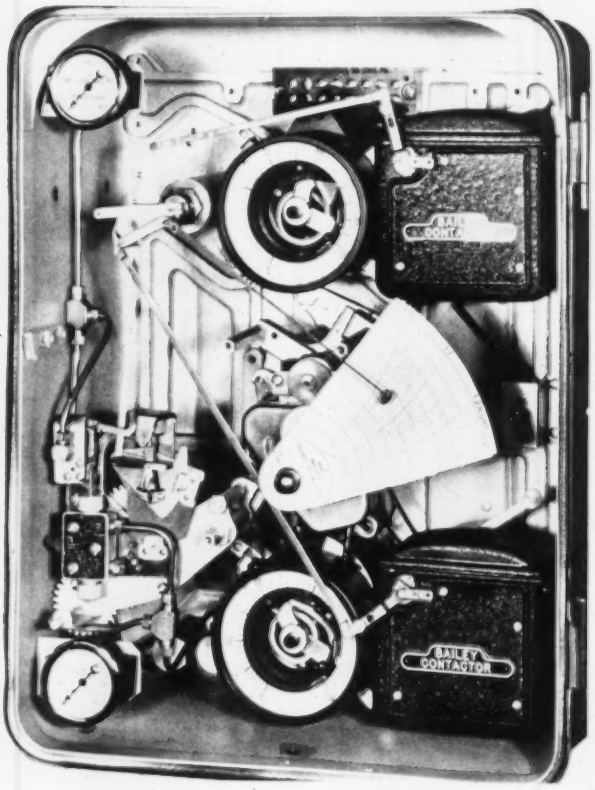


Fig. 13. Interior View of Charge Meter.

The successful application of density equipment to the control of commercial cracking units enables the conclusions to be drawn that when rate of charge, temperature, and pressure readings are supplemented by measurements of density *in situ*, means are available:

(1) For controlling accurately the cracking equipment to maintain a predetermined optimum yield per pass, and making possible a high standard of operating efficiency;

(2) To provide a stable and flexible control based on the utilization of the fundamental variables of the process;

(3) For confining within safe limits the effects of major disturbances which may arise from operating emergencies;

(4) For the accumulation of information essential in the proper design of flow systems.

ACKNOWLEDGMENT

The authors wish to acknowledge the coöperation and assistance of the Bailey Meter Co. in the preparation of the photographs and diagrams used in this paper.

Instrumentation of Solvent Dewaxing Process

Continued from page 94

There is nothing unusual in the installation of the instruments except that all differential and gage leads handling waxy mixes are served with ¼" solvent flushing connections at the instrument for washing the leads toward the pressure point. The system consists of a ½" or ¾" header taken off the solvent charge pump run to the rear of the panel with ¼" needle-valved branches to each lead. The header back of the panel is usually equipped with a drain to the solvent system. With this arrangement any individual lead may be drained through the closed system without causing a mess at the back of the board.

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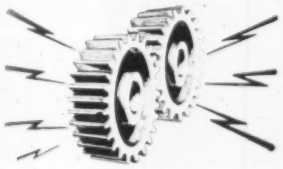
ECTRIC CONTROLS FOR INDUSTRY



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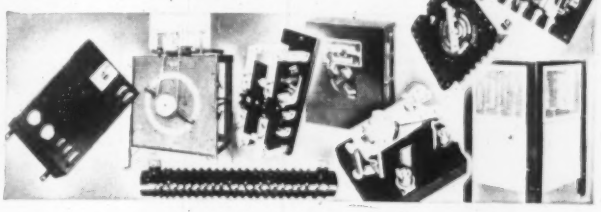

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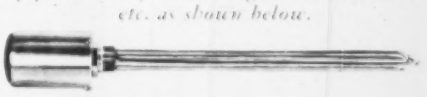

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